PHD

‘The Silk Road Hybrids’

Cultural linkage facilitated the transmigration of the remontant gene in Rosa x damascena, the Damask rose, in circa 3,500 BCE from the river Amu Darya watershed in Central Asia, the river Oxus valley of the Classics, to Rome by 300 BCE.

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'الحرير الهجينة الطريق'

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A Silk Road Hybrid

Rosa x damascena, the Damask Rose [Fig.1]

Abstract

The only rose species carrying the remontant gene were thought to be *Rosa chinensis and Rosa rugosa* whose geographical distributions lie well to the east of, and isolated from, Central Asia; and *Rosa fedtschenkoana* whose distribution extends only as far East as Uzbekistan. This thesis proposes instead, that commencing in circa 3,500 BCE cultural linkage facilitated the transmigration of the remontant gene in *Rosa x damascena*, the Damask rose in horticultural nomenclature, from the river Amu Darya watershed in Central Asia, to Rome by 300 BCE.

Remontancy in western garden roses was thought to have been introduced into Western Europe in the form of the Damasks by 15th. Century, and more certainly in four *Rosa chinensis* hybrids, from China into Britain by 1780. This research found evidence in the works of Classical writers, notably Columnella, Dioscorides, Pliny, Theophrastus and Virgil, that the remontant *Rosa x damascena* was cultivated in Rome by 300 BC. They variously named the repeat flowering rose *Rosa x damascena*, the Damask, or the 'rose of Paestum' as the 'pestane rose', or 'biferique rosaria Paesti'. These writers described the cultivation of the rose from 'suckers', a word that this research shows, was misleadingly, mistranslated.

This research supports the DNA analysis in 2000 of Iawata *et al*, which demonstrates that, *Rosa gallica, R. moschata* and *R. fedtschenkoana* are the parents of the Damask. Plotting, recently revised, geographical distributions of the Damask's parents show an overlap. This overlap shows that not only natural hybridisation between the three parents was possible, but significantly the overlap, the point of origin of *Rosa x damascena,* is located within the river Amu Darya watershed.

The Classical writers describe the location, the date, and the process, for the production of rose water from the petals of the Damask. This cultural link between the Damask, and rose water production, evidenced the transmigration of the rose from Central Asia, through Persia, Turkey and the Middle East, and from there to Rome. Locations for rose water manufacture, plotted on a map, correlate with the route of what is now known as, The Silk Road.

In support of the practical, horticultural viability of this transmigration, a field survey in 2015 revealed that the methods of transporting plant material, the method of propagation, and the cultivation of the rose in the hot, harsh and arid climate of the Dadès Valley in Morocco today, mirror the methods practiced in similar climatic conditions along the Silk Road in antiquity. Research shows that rose water has been used in religious ceremony for at least 4000 years, throughout Central Asia, Persia, the Middle East and the Mediterranean. Surprisingly, no evidence has been found to show that spread of the Damask correlates with the spread of faiths and beliefs, that is, until the spread of the Moslem faith from 700 CE. Conversely the spread of the use of rose water in medicine, hygiene, sanitation and fragrancing are well documented by the Classic writers. Research into the pharmacology of rose water, and its use in the treatment of a wide range of ailments, shows that in antiquity, the same ailments were successfully treated in Central Asia, as they were in Rome.

In conclusion, *Rosa x damascena*, the Damask rose, together with its remontant characteristic, extended it geographical distribution from Central Asia from 3500BCE, to Rome by 300 CE, incentivised by man's demand for and health, hygiene and fragrance. Despite this cultural linkage, there is a paucity of evidence for the establishment of the Damask spreading further west as a garden plant, until the 18th. Century. Since then, rose hybridists have used the Damask to breed the remontant, large flowered, fragrant western garden hybrids much loved by gardeners today.

Table of research findings	*Unpublished, research by Mattock # Sourced from other's research
The rose carrying that carried the remontant gene to Rome by 300 BCE was *Rosa x damascena*, the Damask Rose.	#
The geographical distribution of the rose species, *Rosa gallica, Rosa moschata* Herrm and *Rosa fedtschenkoana,* the parents of *Rosa x damascena,* overlap.	*
The point of origin of *Rosa x damascena* has been derived from the overlap which when plotted on a map shows the location to be the river Amu Darya watershed, in Central Asia.	*
Rose water, rosaceum and rose oil is produced from the petals of *the* Damask.	#
The connection between the Damask and rose water production in antiquity was established from reading descriptions of the production in the Classics. Notably, those written by Columnella, Dioscorides, Pliny and Theophrastus and Virgil.	*
The cultivation of the Damask for rose water production is described in detail in the Classics. However, Latin and Greek translations of the original sources have misleadingly confused the word for 'sucker', the term for the material used to propagate the Damask, with the words for saplings, cuttings, reeds, screws and twigs. The latter would have perished in the climate of the Silk Road, and consequently the Damask would not have transmigrated.	*
The use of rose water and the cultivation of the Damask spread in tandem, because of the demand for the product in health, hygiene, sanitation, medicine, and fragrancing.	*
Rose water production spread west along the routes used by merchants and religious refugees, namely The Silk Road and the Royal Persian Road.	*
Dates and locations for the transmigration of the Damask, derived from Classical texts, have been plotted on to a time line and onto a map. The map evidences and illustrates the passage of the Damask from Central Asia to Rome.	*
Cultural linkage enabled the geographic spread of the manufacture of rose water, and in consequence the transmigration of the remontant gene in the Damask along the Silk Road to Rome.	*
Rose water manufacture virtually ceased circa 350 CE, and recommenced with Islamic expansionism from circa 800 C.	#
The thesis examines whether beliefs and faith were the driving force behind the cultural linkage, and concludes that the use of rose water in health, hygiene and medicine transcended religious fervour. Map plotted.	*
The thesis fills a significant gap in the knowledge of how the Damask rose played such a pivotal role in the history of the rose.	*
Lastly, the thesis proposes a new perception, a new history, of how repeat flowering, large flowered, strongly fragrant garden roses arrived in the West.	*

Compliance, Copyright & Acknowledgements

Declaration of material from a previously submitted thesis and of work done in conjunction with others.

A Case Study in the History and Theory Unit.
Submitted by Robert Mattock,
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Dedication

To the late Robert H. Mattock who taught the author how to grow roses and an appreciation of antiquity.

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Chapter 1.

Introduction

This thesis proposes that cultural linkage facilitated the transmigration of the remontant Damask rose, *Rosa x damascena,* from its wild origins within the river Amu Darya watershed in Central Asia, along the Silk Road and along its main artery, the Royal Persian Road, to Classical Greece and Rome by the third century BCE (Pliny citing Callimachus & Apolonia) [i]. Hence the name, the Silk Road Hybrids, adopted by, and the title of, this thesis. This work has given rise to a new perception of both the origin and of the history, of the strongly fragrant, large double flowered, recurrent flowering roses, much beloved by Western gardeners.

The significant features of this new research are fivefold.

A literary review of the identification of *Rosa x damascena* as the remontant rose described in Classical texts, and the identification of the Damask rose as the rose depicted in the literature and art of Rome in c.300 BCE.

Secondly, the previously unpublished determination of where the Damask originated, its botanical *point of origin*. This has been revealed by plotting the recently revised overlapping geographical distributions of the Damask's parents within the river Amu Darya watershed.

Third, whilst botanical data does not reveal when a plant becomes established in any specific region, this research, for the first time, links the Damask rose with the commercial production of rose water. The dates of when production took place are known because the processes are described in great detail in Classical texts dating back to 2500 BCE. The texts are dated, and also describe the locations where rose water was produced. These data have enabled the passage of the Damask rose along the Silk Road to be plotted on a time line, and the dates of the passage plotted on maps.

Four, the dates and direction of the passage of the Damask through Central Asia to Rome, have been plotted on maps illustrating the evolution of the faith and belief systems of the regions that use rose water in religious ceremony. This latter study has shown that the transmigration of the Damask, and the corresponding use of rose water, transcends the barriers posed by religion, politics and empire building in favour of demand for health, hygiene and fragrance.

Lastly, the connotations of this transcendence are explored in respect of how the Damask rose might be reintroduced in to war torn Syria as a humanitarian project.

Our Eurocentric horticultural world has insisted that remontancy, the ability to flower repeatedly or recurrently from June until the autumn, arrived in the West during the late eighteenth century from China. Remontancy is a highly prized gardening attribute, because the remontant rose produces more flowers than its once flowering relatives, which only flower for four or five weeks each year. This thesis proposes that the Damask from Central Asia was the first rose to exhibit remontancy, in Western Europe. Not only that, but three thousand years earlier than had been previously thought. Why had remontancy in

the Damask been ignored by rose historians? From a Pan-Middle Eastern and, Pan-Asian perspective, the Damask is rarely considered a garden plant. Conversely, parts of the Mediterranean, all of the Middle East and Central Asia, and much of the Far East, recognise the Damask for having significant economic and commercial value, not as a garden plant, but rather, as a main stream horticultural crop. Consequently, it was not the Roman gardeners who sought the remontant rose for ornament, rather the Roman rose growers who sent envoys to research the manufacture of and use of rose water from the rose's petals. Whilst visiting the Villa Guilia in Rome (National Etruscan Museum 2016)[ii], the author marvelled at just how the Damask rose, depicted in frescoes of the sixteenth century, and painted on the walls and ceilings of the loggia, were painted with such great horticultural accuracy [Fig. 2]. The paintings support the findings of respected rose historian, Peter Harkness that the remontant Damask garden roses appeared in European gardens in the 15th Century[iii]. The frescos in Villa Guilia, with artistic licence, illustrate the use of the Damask rose as garden plant. Artistic licence? Because having grown several thousand plants of this species, as a professional rose grower for sixty years, in the author's experience the Damask does not grow tall enough to cover the trellises depicted. Never the less, the frescoes [Fig.2] by the mannerist Bronzino (1503 – 1572)[iv] (Tate 2016) are painted with sufficient botanical accuracy that, with a nurseryman's eye, the rose could readily be identified as one of the great garden plants we know today.

[Fig. 2] Damask and Gallica roses depicted as garden plants on the frescoes under the colonnades of the Villa Guilia in Rome.

The author was at the same time reminded of roses in Rome of an earlier era, this time the roses portrayed by Sir Lawrence Alma-Tadema (1836-1912) in his painting of 1880 *The Roses of Heliogabalus* [Fig.3]. The Syrian born, Roman emperor Heliogabalus (203 – 222 AD)[v], gave dissolute weekend parties that purportedly ended with the emperor pouring masses of rose petals over his scantily clad, inebriated, spent, malodorous and recumbent guests. Rose water and rose petals were an important factor in hygiene, sanitation, medicine and fragrancing in classical Rome and Greece [vi] (Mello 2003). The writers,

Theophrastus, Columnella and Pliny [vii] (Mello 2003) describe the roses that were used, in such botanical detail, that it has proven possible to identify the plants as the Damask. The painting owned currently by the Spanish-Mexican art collector, Juan (Simon 2014)[viii], illustrates one means by which Roman Christians associated the rose with dissolute and decadent behaviour, so much so, that from c.200 AD on the rose was hardly used and barely mentioned in the literature of what had had been the Roman Empire, until four hundred years later. These two paintings, [Fig. 2] and [Fig.3] serve as a reference to three of the questions posed by this thesis. How, why and when did remontancy arrive in classical Rome in the genome of the Damask Rose? Why did the Damask rose not feature as a garden plant in antiquity? Did the rose really disappear from Classical literature with the demise of the Roman Empire?

[Fig.3] *The Roses of Heliogabalus* Alma-Tadema (1888) Detail. The petals grown commercially stifled the odour of the decadence.

The world of rose enthusiasts, western gardeners in particular, have believed for three hundred years or more, that roses and remontancy in roses in originated in China and that those roses remained in Oriental isolation until the late 18th. Century. Garden historians acknowledge that gardens evolved from their origins in Sumeria and Persia over 2500 years ago (Hobhouse 2003)[ix], and from there influenced the style of Italian, Spanish, French and English gardens, with, the author would suggest, scant use of roses until the seventeenth century. Why did the Romans and Greeks, who were absolutely besotted with roses, do not have appeared to have used them extensively as ornamental garden plants? Wilhelmina Jashemski (1910-2007) leading scholar on gardens and horticulture in the ancient city of Pompeii [x] does not mention roses, apart from those used in floristry for perfumery and for making garlands. Nor were

they widely illustrated during the Romano-Greek era. A notable exception being the rose depicted in The Painted Garden of the Villa of Livia [Fig. 95. P121).

The answer is that people in those Classical eras used the rose not primarily as a garden plant, but rather they grew the plant as a mainstream, horticultural crop. A crop grown alongside their wheat, barley, oats and maize. The petals were, and still are, harvested for their fragrant oils which were and are still used to produce rose water, rose balm or unguent, and from the twelfth century, used to produce rose oil. The rose was, and still is, grown on enormous scale throughout the whole of Asia, and particularly Central Asia and the Middle East. The products were used in huge quantities in the malodorous, unhygienic world of antiquity, for perfuming a world of unwashed sweaty bodies, in medicine and in religious ceremony, and in floral decoration. The cultivation, the manufacturing process, and the use of rose water, by whom and for what purpose, is recorded in great detail by writers stretching from the Classical era back to the Assyrians, four thousand years earlier.

The author, with his skills as a professional rose grower, has to an extent been able to critically review the Classical texts describing the commercial rose nursery production of antiquity. The author would not have been able to trace the history of this beautiful rose, otherwise.

One rose species predominates the production of rose water, *R. x damascena,* the Damask, the Persian Rose, about which little was understood until recently. The rose water industry was extensive, (Hehn 1885)[xi] that is until it collapsed towards the end of the Roman Empire. Not until Arab and Islamic expansionism arrived some five hundred years later in the western Mediterranean, was the Damask seen again in Rome, not yet as garden plant, still only as a horticultural crop. It took a further five hundred years for European rose hybridisers to breed the remontancy, form and fragrance from the Damask into the first repeat flowering garden roses of the Western world, fully five hundred years before any Chinese remontant influence. Out of the one hundred and ninety rose species in the world about forty, including the naturally occurring hybrid *Rosa x damascena,* are indigenous to Central Asia. One hundred are indigenous to China, and the rest are spread thinly throughout the northern hemisphere. Roses come in a variety of shapes and sizes; they grow as climbers, ramblers, crawlers, shrubs, bushes, and there are miniature or dwarf forms of all of these. *Rosa x damascena* is a naturally occurring, remontant hybrid, a cross between a rambler and two shrubs resulting in a large, lanky bush. Remontancy in the wild is not a European phenomenon. In fact, until research in 2000 evidenced the Damask's Central Asian parentage, the remontant characteristic was thought to be exclusively Oriental.

This thesis is structured in chapters that deal firstly, with the background to hybridisation and remontancy. The following chapter is on the history, botany and the cultivation of the Damask, and a re-assessment of the parentage of the rose. This has provoked a new proposal for the Damask's geographical *point of origin*. Pivotal to the transmigration hypothesis, is an investigation into the translations, in the commentaries of Palladio, Pliny, Virgil, Columnella and Theophrastus, where they refer to the material used for propagating the Damask, as *saplings, reeds, twigs* or *cuttings*. The author

recognised that these types of propagating material would not have survived transportation in the hot arid climate of the Middle East and Central Asia. Due to desiccation it would have been impossible to have kept this material viable. The words for propagation in the texts ought to have been translated as '*suckers*'. Suckers are quite different, horticulturally, from the aforementioned material, and an easy and traditional means of propagating *R. x damascena* under harsh climatic conditions. This 'slip' in translation appears to have led many garden historians up the 'garden path', as opposed to researching the commercial production of the rose.

Following chapters then deal with the use of rose water in Classical Rome, Greece, the Middle East and Central Asia. These comparative studies of the rose's cultivation and its production have enabled the dating of rose water production, and thus the Damask, to be plotted on a time line, and on a map. [Map 16 p.135] The map illustrates the transmigration of the Damask as outlined in the sub title of the thesis. Finally, the thesis discusses the learning outcomes and the validity of the research, and concludes with a set of tables and maps that evidence why and when, the remontant gene in the genome of *Rosa x damascena* arrived in Classical Rome; a new contribution that revises the history of the garden roses in the West. The thesis concludes with a proposal for a practical application of the research. A potential humanitarian project, with an economic value, which aims to re-introduce the Damask, and rose water and rose oil production, into currently war torn, Syria.

Chapter 2.

Methodology

Cultural linkage facilitated the passage of the Damask rose, otherwise known by its scientific name *Rosa x damascena*, from the river Amu Darya watershed in Central Asia, to Rome. Consequently, this thesis draws on research from a multidisciplinary range of sources which are presented as a series of humanities-led essays, supported by biochemical and botanical evidence in the form of tables and definitions.

Throughout the thesis, the rose has been referred to as the Damask in the context of the humanities, and as *Rosa x damascena* when noted in a botanical or scientific context, simply to allow the text to flow.

The methodology used in attempting to track the transmigration of the Damask from China to Rome, and subsequently, successfully tracking the rose from Central Asia to Rome, has involved several processes. First, an extensive Literary Review has been conducted of both classical and contemporary literature searching for references to the Damask rose, the cultivation of the rose, and its uses both historically and currently. Contemporaneously during the same review, archaeological finds, paintings and illustrations have been investigated, evaluated, and interpreted from a horticultural perspective. Second, reports of laboratory based DNA analyses have been analysed in an attempt to confirm the identification of a series of assessions of *Rosa x damascena*. Assessions are plant material that has been collected from a particular area in the wild.

This thesis reports on the biochemical constituents of over forty assessions of *Rosa x damascena,* hence the title of the thesis, *The Silk Road Hybrids*, rather than the singular *The Silk Road Hybrid*. Lastly field trips to Morocco and Italy have been undertaken to make a comparative study of historic and contemporary methods of rose cultivation and the rose water production process, to assess the viability of the method of transporting propagating material across harsh and arid terrain in a very hot climate; and then planting and growing-on the material under those same conditions.

2.1. Literature review.

An evaluation of the translations of Classical literature in respect of how the rose was cultivated has been an important factor in determining whether it was possible to transport the Damask in its passage along the Silk Road. Without the academic Classicist's keen eye for historic vocabulary and translation, but nevertheless with the experience of a plantsman and nurseryman, it has proven possible to reinterpret the translations by academics, of the original Classic writer's literary text and phraseology, into horticultural terminology [p.75].

Evaluating sources of information is an important step in research, because the validity of the available information varies dramatically. For example, traditional print sources go through an extensive publication process that includes editing and article review. The process has layers of fact-checkers, reviewers and editors to ensure the quality of the publication. Conversely, almost anyone with a computer and access to

the Internet can publish a Web site or electronic document which has not been subjected to peer review. Consequently, this thesis has given considerably more weight to printed sources, than to internet sources, on the premise that only qualified authors are likely to have their manuscripts accepted for publication. The purpose of an online text may also be misleading because, as opposed to print, Web sites are a cheap and easy means of disseminating information to create an effect that has little to do with the work's academic content. This is particularly poignant in the chapters dealing with beliefs, faiths and Islamic Expansionism.

2.2 Classical references

The thesis relies heavily on translations of the Classics for information on the cultivation of the plant, and the processing of the flowers and roots into rose water and other by products. The *Loeb Classical Library*, 2016, has been used as the referencing authority to the principle sources, throughout the thesis, both in the hard library copy, and in the *Digital Loeb Classical Library*. Dr. Robin Lane Fox and also The Reverend Richard Smail, both Oxford University classics scholars, have advised on translation when the translations and commentaries in Loeb appear ambiguous in respect of horticulture.

2.3 Laboratory analyses.

ISSR-PCR DNA analyses were evaluated for the validity of their application in identifying assessions of *Rosa x damascena* and Central Asian rose species in collaboration with Dr. John Beeching of the University of Bath. Robert Mattock Roses provided the material for the research by a student of John Beeching, ara Breeze, into the phylogenetics of a range of hybrid roses. The author was permitted to observe her methodology as she ran the experiments and constructed a dendrological table.

The results of the analyses of the constituents of rose water and rose oil have been gleaned from a number of botanists, biochemists and agronomists particularly those from Iran, Syria and Turkey. A comparative study was made to explore the genetic linkage between the assessions from one country to another and then depicted in a series of tables.

2. 4 Field research

Rome

Three field trips were made to Rome during July 2010, September 2011 and January 2012, for the purpose of surveying evidence for roses in archaeology and frescos from the Classical period, and to view paintings and illustrations by the 16th. Century Mannerists.

Morocco

An expedition was mounted in April 2014 to Kalaat M'gouna in Morocco, located on the Dadès River in the Sub-Saharan Desert south of the Atlas Mountains, to see first-hand, the cultivation of *R. x damascena* in the dry, hot climatic conditions, and arid harsh terrain analogous to that of the Middle East and Central Asia.

Mattock's Lodge Hill Nurseries and records of remontancy.

Observations of increasing levels of remontancy in roses forced under glass were recorded on the Robert Mattock Roses nursery near Oxford, over the period 1985 to 2012.

Establishment of a Field Station at Thenford

Lord Heseltine has facilitated a research project on the nursery within his arboretum, which aspires to trace the remontant gene in Central Asian Rose species, particularly those from the Levant. Wild collected seed from plant collectors is being germinated in Oxfordshire in preparation for subsequent DNA analysis at the University of Bath. The author has drawn on his experience gained from observing the Damask rose during visits, in a professional capacity, to Egypt, France, Germany, Spain, Greece mainland, the Aegean and the Cyclades from 1975 to 2015.

2. 5 Tables & Maps plotting geographical distributions

Analysis of the research has permitted the compilation of a set of comparative studies depicted in the form of a series of tables and maps, which illustrate for the first time, when and where Rosa x damascena originated, and again for the first time, how the plant transmigrated to Rome. The following National *Floras* have been used to reference the geographical distribution of the rose and its parents and putative parents. *Flora of Afghanistan* (Kitamura 1960) (Flora Iranica)[xii], *Flora of China* (Zhengyi 2004).[xiii] *Flora of Iraq* (Ghazanfar 2017)[xiv] , *Flora of Kazakhstan* (Pavlov 1961)[xv], *Flora of Kyrgyzstan* (Sennikov, Uotila 2016)[xvi] *Flora of Palestine* (Von Jaffa 2009)[xvii] *Flora Pakistan* (Raven 2000)[xviii] *Flora of Syria & Sinai* [xix] *Flora of Tajikistan*[xx] *Flora of Turkey* (Davis 2016)[xxi] *Flora of Turkmenistan* (Kurbanov 1994)[xxii] *Flora of Uzbekistan* (Sennikov 2017)[xxiii]*Flowers of the Himalaya*[xxiv] (Polunin & Stainton 1997), *A Naturalist in Western China* (Wilson 1913)[xxv] All Floras are heavily reliant on their sources, that is the observations and records of botanists and plant collectors in the field. These weighty volumes once published irregularly, they today in an era of rapid global communication and translation publish up-to -the minute data.

Time-lines and Maps plotting the transmigration of the Damask rose.

Quantification, or qualification, of when and where the Damask settled during its transmigration in antiquity, presented a conundrum because botanical descriptions do not impart such information. There are however a great number of references that rather than describe the plants themselves, describe the cultivation of the rose and the process of the production of rose water. Consequently, plotting the geographical location and date of where and when quotations were written, and the dates and locations to which the quotations refer, has enabled the production of a time line that illustrates within an acceptable degree of precision, when and where the rose settled at any one time plus or minus 500 years. Indeed, the time line illustrates the transmigration of the Damask from Central Asia to Rome.

2. 6 Selected Background Reading

The recent trend for 'Googling' to evaluate and to learn about a subject, by reading specific, stand-alone scholarly papers, largely removes the prospect of being able to see that subject in its global perspective. There is no short cut to reading authoritative books that encompass the entire subject to gain background perspective from which to evaluate ideas. The bibliography, to be found at the end of the thesis, contains the works that the author has read to be able to take a global view of the subject

Chapter 3

Context.

Searching for the remontant gene in *Rosa x damascena* in this multi-disciplinary thesis involves the introduction of 'cutting edge' scientific research, into the wider world of literary Classics. Consequently, the perspective of this work as a whole can be difficult to follow, therefore this chapter seeks to put the new scientific research into the broader context of existing humanities-based knowledge and learning outcomes.

Pivotal to setting *Rosa x damascena* in the context of the diversity of Central Asian rose species is the investigation into the plants parentage.

3.1 R. x damascena is a naturally occurring hybrid with three parents.

Iwata, Kato, & Ohno, in their seminal paper *Triparental origin of Damask roses* of 2000[xxvi] discovered the parentage of *Rosa x damascena* using DNA analysis. Not only that, and crucial to this thesis, is that they found the pollen parent to be remontant. This broke new ground in so far that it had been thought that remontancy only existed in Chinese and Oriental species. The analysis demonstrated that *Rosa x damascena* is a hybrid, furthermore a naturally occurring hybrid, between three different species; one from Europe, *Rosa gallica*, one from Central Asia, *Rosa moschata*, and one from Western China and the Far East, *Rosa fedtschenkoana*. Are there any other contenders for parentage which might alter the perspective of the proposed distribution, point of origin and pattern of transmigration?

Iwata et al's paper says that "Damask roses are one group of old rose varieties and a key material in old European rose improvement in the 19th century. To clarify the origin of Damask roses, we selected four varieties as the oldest Damask varieties and examined the relationship between the Damask varieties and their putative ancestors at the molecular level. Randomly amplified polymorphic DNA analysis of the Damask varieties proved that they had an identical profile, indicating they were established from a common ancestor. They have never been allowed to reproduce sexually; their reproduction depends entirely on vegetative propagation. We identified three *Rosa* species*, R. moschata, R. gallica* and *R. fedschenkoana*, as parental species of the original hybridization that contributed to forming the four oldest Damask varieties by sequencing the internal transcribed spacer of ribosomal DNA. We also found that all the four oldest Damask varieties had chloroplasts derived only from *R. moschata*, as judged from psbA-trnH spacer sequences. This triparental origin of the four oldest Damask varieties can explain some morphological characteristics of the four oldest Damask varieties, like fruit shape, leaf colour and the 'Moss' character".

Iwata *et al's* paper has been the subject of conjecture because of doubt over the validity of their DNA analysis. Consequently before proceeding further with this thesis that relies heavily on Iwata et al, the argument must be examined and its conclusions dispelled.

3.2 Doubt over the validity of the DNA analysis of Iawata et al. in 2000

It is possible, that Iwata *et al* were wrong. [Chapter 4. p.38][xxvii] While there appears to be little doubt that the hybrid *R. gallica x R. moschata* hybridised to form a cross, it is possible, as explained below, that *R. fedtschenkoana* was not the pollen parent. The Japanese biochemists examined the relationship between Damask varieties, and their putative ancestors, at the molecular level. Random, polymorphic DNA analysis, of the Damask varieties proved that they had an identical profile, indicating that they were established from a common ancestor. Iwata *et al*, identified the three *Rosa* species, *R. moschata, R. gallica* and *R. fedtschenkoana*, as the parental species of the original hybridisation, which contributed to forming the four old Damask varieties used for sampling, by sequencing the internal, transcribed spacer of ribosomal DNA. The author originally felt inclined to support the rosarian and tulip expert, Behcet Ciragan, when he raised issues that appeared to contradict Iwata *et al* (Cirigan 2014)[xxviii]. Was it really *R. fedtschenkoana,* that Iwata and his colleagues found, that carried the remontant gene? The issues that Cirigan raised, threatened to jeopardise the hypothesis of this thesis, consequently they are in explored in some detail below.

First, Cirigan asked where did this hybridisation allegedly take place. "Certainly the rare *R. fedtschenkoana* repeats, but only occasionally". Secondly it is "native to the arid, barren, inhospitable foothills of the Ala Tau, Tian-Shian and Palmir Alai Mountain ranges in central and north west China". Whilst this is the home of the original tulip, it is not where one might expect to find a *R. gallica x R. moschata* seedling" Cirigan 2014)[xxix]. "Would nomads or religious refugees have taken *R. fedtschenkoana* as they travelled west and south? It is a possibility, but improbable. Rose seedlings do not travel easily like tulip bulbs which carry their reserves of nutrient and water in their bulbs". *"*Flora of Pakistan" treats *R. fedtschenkoana* as a synonym of *R. webbiana"*. In support of this notion, *"Flora of the USSR"* states "This species appears to be one of the composite species *R. webbiana".*

The *Floras* of Central Asia, collectively, [see Bibliography] not just the dated *Flora of Russia* that Cirigan quotes, do not support Ciragan's claim. Neither do Philips and Rix[xxx], who actually travelled through the region to discover *R. fedtschenkoana* in the foothills of the Tian Shan within the watershed of the Amu Darya, where the borders of the geographical distributions of both *R. gallica* and *R. moschata* overlap. The question is if Ciragan's measure of the distribution of *Rosa fedtschenkoana* is correct, how, when and where did *Rosa fedtschenkoana* from China get to breed with *Rosa moschata* x *Rosa gallica* of Europe and Central Asia? Geological features, notably the Pamir and Himalayan mountain ranges, and the South West China glacial refugium, do not favour longitudinal hybridisation. Consequently, if at all, the longitudinal transmigration of the remontant gene in *R. fedtschenkoana* would have occurred only through man's intervention, for which there is no evidence. Jennifer Potter proffers the same view as Cirigan, in her history, *The Rose, a True History* p.57, (Potter 2010) [xxxi] ; again, she says that there is no overlap in the distributions of *Rosa fedtschenkoana*, *Rosa moschata* x *Rosa gallica*. Frankly, as this thesis has demonstrated, (Map 7. p.58), they are simply, both wrong.

Cirigan then raised the question "what did Iwata *et al* actually analyse in 2000?" Examination of the material Iwata *et al* used shows that they compared DNA Sections, of five roses received from Beales Roses from Norfolk, U.K. *('Quatre Saisons', 'Quatre Saisons Blanc Mousseaux', 'Kazanlik', 'York and Lancaster'* and '*R. gallica Officinalis'*); three examples of *R. phoenicia;* two of *R. moschata, one* from Chiba University; and a seedling from Chiltern*;* two *R. moschata nepalensis,* from Hiroshima Botanic Garden, in Japan; and one *R. moschata* Plena, from the same assession. Note that none of the above were wild collected. Consequently, Cirigan says "the number of assessions is too narrow to determine whether the real "type" was investigated" and furthermore, "plants in nurseries and botanic gardens, despite being thought correctly labelled, are not necessarily pure, and what they are believed to be, because of their exposure to hybridisation due the promiscuity of the genus, results in a new hybrid". Here Cirigan has a point. A point that the new research project into the identification of Central Asian Rose species aspires to clarify. [Case Study 2 and Appendix 1.]

Cirigan goes on to say that "the Iawata paper states that in the comparative direct sequencing of certain spacer regions of chloroplast DNAs, an exact equivalence was seen between a region *of R. moschata nepalensis* and *R. x damascena*, from which, Iwata *et al* conclude, that *R. moschata* is one of the female parents." "If they are talking about *R. brunonii* Lindll, then we must consider a different hypothesis for the origins of the Damask Rose, since the geographical distribution of *R. brunonii* extends over the Himalayas, Kashmir and Afghanistan". "It appears that Iwata *et al* make no differentiation between *R. moschata* and *R. brunonii".*

Dangerous ground here, because as explained in [4.5. p.69], the gardeners' concept of *Rosa moschata* is far less defined, than that of the botanist, who consider *R. moschata* Herm. to be the *type* and the Accepted name. Taxonomically, *R. moschata nepalensis,* and *R. moschata Plena* are noted in the Plant List as synonyms of *Rosa moschata* Herm. Iawata *et al* may well have considered *R. brunonii* as a female parent *of Rosa damascena,* but despite Ciragan's assertion, it is distinct, botanically, from *R. moschata* Herm. Consequently, it was never discussed during the course of their DNA analysis.

Cirigan says that "one of the primer sequences of *R. x damascena* was identical to that of *Rosa fedtschenkoana,* but regrettably other Cinnamomae-type roses which occur in the same region and which also repeat, for example R. *webbiana* Wall. ExRoyle, and *R. beggeriana* Schrenk, were not analysed to see whether they might carry the same section". (3.16. pp.36-40)

Again, Cirigan has a point, there appear to be several Central Asian Rose species that also exhibit remontancy which are discussed on (3.17 p.42] and detailed in Appendix 1 & 3). The Central Asian Rose Species research project (3.17. Case Stud 2 and Appendix 1 & 3) should add clarity. Meanwhile it would have been prudent of Cirigan to refer to a less dated Flora, than *Flora of the USSR* 1971[xxxii]. In fact, he would have found, *Flora of Russia* 2011[xxxiii] somewhat more illuminating. Meanwhile, in the author's experience, neither R. *webbiana* Wall. exRoyle, or *R. beggeriana* Schrenk, exhibit the regular, stable, remontant characteristic of *R. x fedtschenkoana.* "*Flora of the USSR*" states that *R. beggeriana*

Schrenk is often cultivated in Central Asia as an ornamental, and grown in enclosures". (Flora of the USSR 1971)[xxxiv].

The 1971 Flora does not say that *R. beggeriana* Schrenk is grown for its remontancy, but it does state that its geographical range extends from Xinjiang to Afghanistan, Beludzhistan, Iran, Kurdistan and Eastern Turkey, which overlaps with the distribution of *Rosa gallica*.

Flora of Russia 2011[xxxv] shows this information to be outdated. Furthermore, the *Medicinal Plants of Central Asia,* (Eisenman 2013) [xxxvi] has effectively extended the geographical distribution of *Rosa fedtschenkoana,* and also the range of *Rosa gallica,* to the extent that a significant overlap of some 180,000 square miles (450,000 square kilometres) has been plotted between all three parents.

Interestingly, Tan and Zielinski in "*Two un-named Turkish Roses* (Tan & Zielinkski 2010) [xxxvii]describe two old garden roses found in Anatolia, named *Tevrisi gulu,* and *Kismiri gulu,* respectively, which were first identified by Baytop as *R. laxa.* Var. *harputensis* (Baytop 2001) [xxixxxxviii] This is the very fragrant, milky white, double flowered cultivar, used for sweetening the mulberry treacle known as "*dur pekmeze*". Tan & Zielinkski have identified this plant as *R. beggeriana* which they say flowers from "May to August, and June to September Kashmir". Is this then, the remontant gene carrying parent of *R. x damascena,* rather than *R. fedtschenkoana*? The proposal, that *Rosa begerriana* might be the pollen parent of *Rosa x damascena* might have been supported by Samiei *et al*, (Samiei 2010) [xxxix] The Iranian researchers, have established a distinction between *R. beggeriana* accessions from Tehran, Hamedan and Mazenderan, and a double flowered variety found in Hamedan. This is unsurprising since *R. beggeriana* has been found to be a composite species. The question arises, is *R. fedtschenkoana* part of that composite group, a question that it will not be determined until clarification by DNA analysis. Interim, even should *Rosa beggeriana* prove to be the pollen parent, it has not passed any of its recognisable morphological characteristics to *Rosa x damascena*. Consequently, given that Iwata *et al*, found *Rosa fedtschenkoana* during their DNA analysis, and that this thesis has shown that the geographical distribution of *Rosa fedtschenkoana* overlaps with Iwata's other proposed parents, in the absence of further evidence, it is safe to assume that *Rosa fedtschenkoana* is the pollen parent.

There is also conjecture by Mark Widrlechner in respect of whether *Rosa phoenicia* from the Levant is a parent of *Rosa x damascena*. (Widrlechner *1981)* [xl] Widrlechner claims that *R. x damascena* was originally an eastern Mediterranean hybrid between *R. gallica* and *R. phoenicia* whose distributions over lap. Furthermore that *Rosa x richardii* Rhed. Is of the same genetic stock. The Widrlechner paper was written in 1981 prior to the advent of DNA analysis and thus relied on morphological characteristics and the historic genetics of that time. Never the less he raises several points that post DNA are still of interest. He questions the role of Rosa centifolia.

3.3 Rosa x centifolia

There is confusion over the plant known today as *Rosa × centifolia* and the plant that the Romans knew as *"centifolia"*. There is further confusion in the Latin-English translations between the rose, *centifolia*, the *rose of Cyrenæ*, the *rose of Paestum* and the *roses of Præneste and Campania.*

Rosa × centifolia syn. *R. gallica* var. *centifolia* (L.) Regel), is a hybrid rose also known as the Provence rose or cabbage rose, or *Rose de Mai*. Its point of origin is unclear. Quest Ritson (2003) says that it appears to be the result of a cross between the *Gallicas* and the *Damasks* in late in the 16th. Century, probably by Dutch rose breeders. The thirteenth-century agricultural and horticultural manual, *Āsār va aḥyā'* by Rashid al-din Fadl-allāh Hamadānī (1247? -1318), mentions rose varieties with one hundred and even two hundred petals, and the *Irshad al-zirā'a* refers to both yellow and red varieties, such as the "fiery centifolia of Mashhad" *(ātish ī mashhadī).* Metaphorical Interpretation of Horticultural Practice in Medieval Persian Mysticism, (Visionary Rose 2007) states that the centifolia was introduced into Europe via the Netherlands in the sixteenth or early seventeenth century, either directly from Iran during the reign of Shah 'Abbas I, a period of vigorous trade relations and cultural exchange between the Safavid state and Holland. Or else through the Ottoman Empire during the time of Sultan Süleyman the Magnificent, whose court evinced an unprecedented interest in the culture of flowers, and in roses and rose oil in particular. Medicinal Plant India (2009) states that *R. x centifolia* is synonym of *R. x damascena*.

There are such striking similarities between the parentage and the reported transmigration from Central Asia to Europe in antiquity of *Rosa x damascena* and *Rosa centifolia* that a hypothesis that *R. x centifolia* is a sport or mutation of *R. x damascena* must be given serious consideration. The research detailed in Case Study 2, that is investigating the Evolutionary Genetics and Taxonomy of rose species indigenous to the Levant and Central Asia should confirm this issue one way or the other.

Against this back ground, the identification of *R. x damascena* of antiquity becomes clearer. Descriptions of ancient roses are to be found in Pliny the Elder's *Naturalis Historia*. *The rose: twelve varieties of it.*[xli] Pliny discusses each of the twelve varieties, but he doesn't taxonomically differentiate between hybrids and species. The following is from the translation by John Bostock, M.D., F.R.S., H.T. and Riley, Esq., B.A., Ed. (1855) who refer frequently to an earlier translation by *Fée* (*1826*).

"The most esteemed kinds of rose among us are those of Præneste and Campania. The same rose, probably, of which Virgil says, Georg. B. iv. l. 119, "Biferique rosaria Pæsti"—"And the rose-beds of Pæstum, that bear twice in the year."

"The number of the petals, which is never less than five, goes on increasing in amount, till we find one variety with as many as a hundred, and thence known as the "centifolia:". Bostock says that "this rose is still known as the "*Rosa centifolia*." "Its petals sometimes exceed *three* hundred in number; and it is the most esteemed of all for its fragrant smell in Italy, it is to be found in Campania, and in Greece, in the vicinity of Philippi, though this last is not the place of its natural growth". "Non suæ terræ proventu."

“Cæpio, who lived in the reign of the Emperor Tiberius, asserts that the *centifolia* is never employed for chaplets, except for the tips "Extremas velut ad cardines." Because “the rose is remarkable neither for its smell nor its beauty”. “And, indeed, the genuine rose for the most part, is indebted for its qualities to the nature of the soil. That of Cyrenæ (The Rosa Damascena of Miller, Fée thinks), our Damascus rose is the most odoriferous of all, and hence it is that the unguents of that place are so remarkably fine: at Carthage, again, in Spain, there are early roses throughout all the winter”.

“genera eius nostri fecere celeberrima praenestinam et campanam; addiderealii milesiam, cui*u*s ardentissi mus colos, non excedentis duodena folia, proximam et trachiniam minus rubentem, mox al*a*bandicam vili orem, albicantibus foliis, vilissimam vero plurimis, sed minutissimis, spiniolam. differunt enim multitudine foliorum, asperitate, levore, colore, odore. paucissima quina folia, ac deinde numerosiora, cum sit genus e ius, quamcentifoliam vocant, quae est in campania italiae, graeciae vero circaphilippos, sed ibi non suae te rrae proventu”.

Caveated by the fact that species roses and their hybrids, generally, vary morphologically to a considerable extent in terms of fragrance, number of petals, nature of growth, and according to which soil type they are grown, the descriptions above of the *centifolia*, the *rose of Cyrenæ*, and the roses of *Præneste*[49] *and Campania,* and the *roses of Paestum* appear to be one and the same rose.
The Latin translation would have been more precise perhaps, had it stated the “*Damascus rose from Cyrenæ”*, the “*Damascus rose from Paestum*”, and so on.

Widrlechner describes the introduction of *Rosa x damascena* into Israel[xlii]. Jericho and Jerusalem were the centres of production and a full range of rose extracts were produced. (Gilad 1975)[xliii]. Felix Fabri (1460)[xliv]extolled the beauty of the Jericho roses but by the 1800s the fields had gone wild and production declined. Baron E. Rothschild tried to establish a modern rose oil industry in the late 1800s but manufacturing difficulties and pathogens halted production in 1905 (Gilad 1975).
Widrlechner goes on to describe various research programmes. The ‘Research Institute for Oil-Bearing Roses, Aromatic and Medicinal Cultures’ at Kazanlik, Bulgaria has improved the production of rose extracts from the local *R. x damascena* cultivar ‘Kazanlik’ by 90%. Milewski has used *R. x damascena* as a patent for the creation of the multipurpose cultivar ‘Memory of Wieslaw Milewski’ (*R. x damascena* x *Rosa rugosa* Thunb.) In Russia breeding and testing has been in progress since 1962. The selection ‘Rimean Red’ has been grown along the Black Sea since 1926. Two of the best new cultivars are ‘Michurin’ and ‘Festival’ whose oil yields are about twice as great as ‘Kazanlik’. Russian research continues at the All Union Scientific Research Institute. Widrlechner investigates the Taxonomy and Genetics of *Rosa x damascena.* He makes the point that roses are noted for their intergradations and hence the difficulties of classification; that is of course prior to DNA analysis. He says that the range of *R. x moschata* and *R. gallica*

do not overlap which we of course now know that they do. Not least we have the evidence of *R. gallica* collected from Tajikistan and now established at Thenford.

Hurst 1941 advanced the theory that *ER X damascena* was a hybrid of *Rosa gallica* and *R. phoenicia* because the parents have overlapping ranges in the coastal regions of Turkey (Boulenger 1932, 1933, 1936. Post 1932; Nilsson, 1972; Komorov, 1940; Losifovic, 1972. The two species are allopatric, namely they occur in separate non-overlapping geographical areas. *Rosa gallica* is extremely polymorphic (Boulenger 1936) and has already been implicated in the parentage of the hybrid similar to *R x damascena*, that is *R. x richardii.*

Both Hurst and Widrlechner working before the advent of DNA analysis had good reasons based on morphological observation and elementary genetics for proposing *Rosa gallica* and *R. phoenicia* as true parents of *R. x damascena*. They have both been shown to be wrong. Iawata et al's DNA analysis, despite unfounded doubts to its veracity have revealed the true parentage. Revised distributions and ranges of *Rosa fedtschenkoana*, *Rosa gallica*, and *Rosa moschata*, have allowed the point of origin of *Rosa x damascena* to be plotted for the first time.

There is further work to be done. The research programme described in Case Study 2 (p.42), 'The Evolutionary Genetics and Taxonomy of *R. moschata* and *R. phoenicia'* seeks to address the issues of the parentage and distribution of both, and in particular whether there was ever a second *R x damascena* growing in the Levant and S. E. Mediterranean. If so could that have been *R. centifolia or R. x richardii.*

From the perspective of a professional rose grower, *R. x damascena* exhibits a great many forms in the number of petals, number of flowers and its growth many of which are very similar to what we know as *R. centifolia* and *R. richardii*. It could easily be that we are talking about different forms of the same plant.

3.4 Geographical Point of Origin

There is precedent for plotting the geographical distribution of parental species of plant hybrids to ascertain the plant's *point of origin*. (New Scientist 2014)[xlv] . However, the correct distribution of the pollen parent, *Rosa fedtschenkoana*, had yet to be fully plotted until 2013 (Eisenman 2013) [xlvi] consequently, it did not appear to overlap with the other two parents, causing doubt as to whether it was truly a parent. The research for this thesis in 2015 over lapped the geographical distribution of *Rosa fedtschenkoana*, with *Rosa gallica*, and with *Rosa moschata*, allowing the point of origin of *Rosa x damascena* to be plotted for the first time.

3.5 Species definition

This thesis premises that rose species hybridise with each other either naturally, or through man's intervention. However, the very concept of species in *Rosa* is not clear cut, which makes determining the parentage of the Silk Road Hybrids complex. There is no definitive rose species collection in Europe; accordingly, in an attempt to resolve at least some of the aforementioned complexities, a living collection of rose species, the *Mattock-Heseltine Rose Species Collection*, has been established at Lord Heseltine's garden and arboretum at Thenford, near Banbury in Oxfordshire. The project is the subject of future research (Case Study 2 p.42 & Appendix 1.). It is worth noting that as recently as 1994, the concept of rose species was still not clear-cut, and that a universal definition had yet to be finally agreed. Perhaps the most generally agreed definition at that time, was that species roses breed true to themselves, and that group of like plants, growing in an area where there has been no outside influence, reaches a stable state" (Scott Hansen 1994) [xii]. However, simply because a rose is wild and indigenous, it is not necessarily a biological species. Over millennia there could have been cross pollination, where the dominant genes have had ample time to settle to achieve a character of their own. Consequently, the argument is that many 'species are natural hybrids, denoted with an 'x', which have achieved stability, *Rosa x damascena* being one.

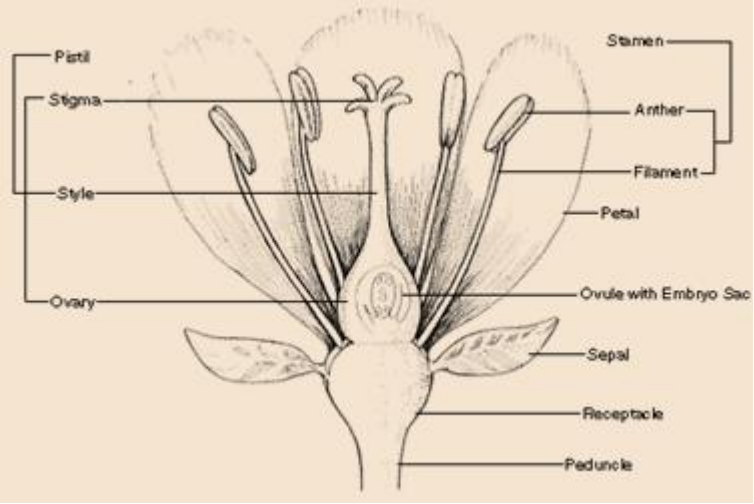
Research into polyploidy in rose species that is anything more than the parental homologous sets of chromosomes, is significant to this thesis in respect of determining the phylogeny, the parentage, of *Rosa x damascena*. The parentage proposed by Iwata *et al* (2001), is that *R. x damascena* is a hybrid of *Rosa gallica* crossed with *Rosa moschata,* which then crossed with the remontant *Rosa fedtschenkoana*. The role of *R. fedtschenkoana* in the parentage of *R. x damascena* has been the subject of doubt. Other species, including *R. brunonii, R. moschata, R. ruscinonesis, R. abysinica, R. freitagii, R. godefroyne,* and, or *R. sambucina* have all been proposed as possible remontant, pollen parents. The author no longer supports this 'scepticism' [Chapter 3.1 .p. 21]. Nevertheless, because the issue of the parentage of *R. x damascena* is pivotal to this thesis, the element of doubt has been the subject of investigation. Furthermore, clarification is required to determine whether the proposed alternative parents are true species, natural hybrids or cultivars. An analysis of the phylogenetics of the alternative parents will, in the future, resolve the conundrum. This analysis is the subject of ongoing research into the phylogeny of Levantine and Central Asian rose species. (Case Study 2 p.42 .To add further complexity there is a range of *R. moschata* like roses, of which some are remontant under certain climatic conditions. (Louette 2004, 2005) [xlvii] (Ciragan 2014) [xlviii] (Remay 2014) [xlix] (Mattock 1995, 2015) [l]. Recent research into remontancy (pp.336-38) suggests that remontancy is not a cut and dried characteristic but rather a plants reaction to climatic conditions and to a lesser extent soil type. Species will in the future be identified by their apparent tendency to remontancy depending on where and when they are grown. Whilst roses have captured the imagination and interests of scientists for centuries, their studies have been conducted within the framework of a classification that is now

largely obsolete, and based on a taxonomic treatment that still relies on the subdivisions made more than seventy years ago, (H urst 1955[li]). In fact, even these may be considered as adaptations of a 19th Century hypothesis (Crepin 1891[lii]Rheder 1940[liii]). Between the years 1922 – 1947, Dr Charles Chamberlain Hurst (1890-1947) the Cambridge luminary led the field of rose genetics. He worked in Cambridge University Botanic Garden. Hurst proposed that the basic chromosome number of roses was 7, and distinguished 5 rose genomes, A, B, C, D and E, each associated with a set of seven rose chromosomes. Diploid roses have chromosomes in pairs so they may be represented as AA or BB etc. In 1955, G. S. Thomas (1909 - 2003, a trainee of Charles Hurst, published Hurst's work on rose genetics in his book *The Old Shrub Roses* (1962)[liv]. This work stood the test of time, until the advent of DNA analysis in or about 2000.

3.6 Hybridisation

Rosa x damascena is a hybrid, the result of hybridisation, a cross, between three different species of rose that occur naturally in the wilds of Central Asia (Iwata *et al* 2000)[lv]. One aspect of this thesis is the promotion of further research into whether it is possible to increase the period of flowering, that is to increase the remontancy, so as to induce the rose in to producing flowers over a longer period, and thus extend the period for rose water production. At the same time, it may be possible to increase flower production through inducing hybrid vigour by crossing the assessions currently in production, or alternatively with other closely related species either through cross pollination, or by genetic engineering. Hybridisation is the process of crossing two genetically different individuals to result in a third individual with a different, often preferred, set of traits; or put another way, hybridisation is the process of crossing two genetically different individuals to create new genotypes. Roses of the same species cross easily and produce fertile progeny. Crosses between unrelated or dissimilar species are difficult to make successfully, and generally produce sterile progeny because of chromosome-pairing difficulties during meiosis. Meiosis is a type of cell division that results in four daughter cells each with half the number of chromosomes of the parent cell. For example, a cross between Parent (1), with the genetic makeup, the genotype, (BB), and Parent (2), with the genotype (bb), produces progeny with the genetic makeup (Bb), which is a hybrid of the first filial generation or (F1). Hybridisation of roses occurs in nature through various mechanisms. Some plants, such as roses, are insect-pollinated and are referred to as 'cross-pollinated plants'. Natural hybridisation has played a significant role in producing new genetic combinations, and is the norm in cross-pollinated plants. It is a common way of generating genetic variability. Plants that have separate pistillate and staminate flowers on the same plant, such as *R. x damascena*, are called monoecious. Plants that have male and female flowers on separate plants are called dioecious.

3.7 The parts of a generic rose



[Fig. 4]. The parts of a generic rose.[lvi]

Legend

Peduncle: The stalk of a flower.
Receptacle: The part of a flower stalk where the parts of the flower are attached.
Sepal: The outer parts of the flower (often green and leaf-like) that enclose a developing bud.
Petal: The parts of a flower that are often conspicuously coloured.
Stamen: The pollen producing part of a flower, usually with a slender filament supporting the anther.
Anther: The part of the stamen where pollen is produced.
Pistil: The ovule producing part of a flower. The ovary often supports a long style, topped by a stigma. The mature ovary is a fruit, and the mature ovule is a seed.
Stigma: The part of the pistil where pollen germinates.
Ovary: The enlarged basal portion of the pistil where ovules are produced.

Artificial, controlled pollination can induce hybridisation and is an important factor in improving both cross-pollinated and self-pollinated plants. The rose breeder must know the season for development of the reproductive structures, the flowers of the rose, and also the techniques with which to promote and synchronise flowering, and pollinating.

3.8 Pollen travel

Natural hybridisation is limited by the distance viable pollen is able to travel from the stud plant to the females on which it is to land. Much work has been done on the distances pollen travels (Pearce 2014)[lvii]. *Rosa x damascena* is not wind pollinated; indeed roses are generally insect pollinated.

For hybridisation to take place, the ripe pollen from one plant, the stud or pollen parent, must be spread by insects, or rarely birds, until it lands to fertilise, or pollinate, the female parts, which are the pistil, [Fig.4] of the mother or seed parent. The plants must be fairly closely related to get the cross to take and the pollen plant must grow within a limited topographical and geographical area in order for insects to fly from one plant to another. (New Scientist 2014)[lviii]

3.9 Implications of hybrid vigour, on horticulture and agriculture.

The concept of hybrid vigour, or heterosis, derives from hybridisation. Heterosis occurs when the hybrid outperforms its parents for a given trait. One of the economic outcomes of an extension to this thesis is

the enhancement of remontancy. The parentage of *R. x damascena* comprises two, once only flowering species, namely *R. moschata* crossed with *R. gallica*. The resulting hybrid, albeit very healthy, is still once only flowering and has no commercial value. However, crossed again with the third parent, the remontant or recurrent flowering species, *R. fedtschenkoana,* this cross throws a highly commercial, remontant hybrid that retains the vigour and health of the first two parents, but in addition has a flowering season twice as long as the first two parents. Should this thesis promote further research in to the genetic modification of the plants remontant gene, it may become possible to induce further hybrid vigour into *R. x damascena* which could increase production of rose water and rose oil, several fold.

3.10 Phylogenics

Genetics & DNA Analysis

The most compelling evidence for the parentage of Rosa *x damascena* comes from the study of phylogenetics of the genus *Rosa* and comparing the DNA, the genetic blueprint, of one species or hybrid with another. Once the phylogenetics are established, the distribution of the parents may be plotted, and an overlap established.

Dr. John Beeching – Genetics

A pilot scheme aimed at comparing the parentage of a range of cultivars grown on the Mattock rose nurseries at Oxford was devised by Dr. John Beeching, Reader at the Department of Biological Sciences at the University of Bath. One of Dr. Beeching's students, Zara Breeze, was set the task of looking at the genetic relationships between a selection of roses from the Mattock nurseries. Under Dr. Beeching's supervision Laura produced a paper *Phylogenetics of hybrid roses analysed by ISSR-PCR (*Breeze 2011) [lix] in which she concludes, "ISSR is a very good technique to use when analysing genetic relationships between these roses. This method was found to be simple and gives clear, reproducible results and is therefore a very good way to look at genetic relationship [xi]. In discussion with Dr. Beeching, it was decided not to run further DNA tests at the University of Bath because there are now a number of commercial operations who offer an efficient DNA testing service, both inexpensively and effectively. This is a fast moving area of sub-molecular botanical research. Almost no sooner than agreement had been reached with Dr. Beeching in respect of the way forward, an international group of geneticists published the results of their work of eleven years in 2015, a comprehensive phylogenetic survey of the genus *Rosa*. (Bruneau 2007) [lx] (Fouge-Daezan 2015) [lxi] . Their work is so comprehensive that it has radically altered the way in which research into the genus *Rosa* is conducted. From the point of view of this thesis, their work crystallised the number of rose species that fall within the geographical area of this study. Never the less the study by Zara Breeze, in which the author collaborated, and was grateful to have the privilege of observing in the laboratory, very adequately illustrates the methodology employed. To that end an extract from her research is summarised ad verbatim below.

3.11 Case Study 1.

Extract from *Phylogenetics of hybrid roses* analysed by ISSR-PCR Zara Breeze 2011

Microsatellite markers

The use of molecular markers highlights DNA polymorphisms, which tend to be highly variable between species and cultivars, meaning that a genetics based method is able to provide a greater insight into the relationships between roses rather than simply looking at morphological features. In particular microsatellites or SSRs (simple sequence repeats) have proven themselves very useful for looking at diversity. The presence and numbers of these repeats tends to vary a great amount between species and are therefore a useful tool for looking at divergence between species and for identifying relationships between plants (Kalia et al, 2011)[lxii]. Microsatellites are a very good method to use, as they are not dependent on the stage of plant development or environment (Crespel et al, 2002)[lxiii]. The main type of repeat that is seen in plant genomes is a simple AT repeat. Microsatellites tend to be a repeated motif of one to six nucleotides; this motif is then repeated between 5 and 100 times per locus, an amount that is seen to be relatively low (Reddy et al, 2002)[lxiv]. They have a high level of polymorphism and are found randomly distributed throughout the genome (Ellegren, 2004)[lxv].

Inter simple sequence repeats.

ISSRs are easy to apply, rapid, cost effective, reproducible and highly discriminating (Crespel et al, 2009) [lxvi] Setting apart ISSRs as a very useful technique in identifying genetic relationships between roses (Crespel et al, 2009) [lxvii]. SSRs have been shown to successfully amplify polymorphic bands which in studies in Iran gave information on genetic diversity in *R. x damascena* (Jabbarzadeh et al, 2010)[lxviii] In this study they examined how the ISSR technique could be adapted for use in roses and tested various primers and PCR conditions in order to amplify polymorphic bands. Crespel et al. (2009) used the ISSR technique to identify different cultivars of a rose, using nine primers they found that 159 bands were amplified, 149 of which were polymorphic, which helped them to differentiate between each of the cultivars tested.

Polymerase Chain Reaction

The Polymerase chain reaction (PCR) is a technique that is used to amplify specific regions of DNA. Oligonucleotide primers are designed flanking the region of DNA to be amplified.

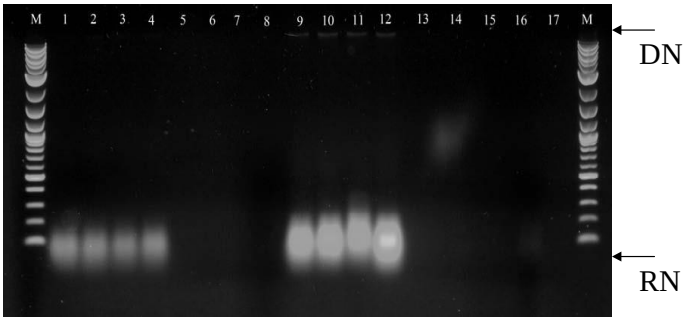


Fig. 5. Initial extraction of DNA from mature leaves, petals, young leaves and leaf buds. The best extraction can be seen from young leaves.
M – NEB 2-Log DNA Ladder. Lanes 1-4, extraction from mature leaves. Lanes5-8, extraction from petals. Lanes 9-12, extraction from young leaves. Lanes 13-16, extraction from leaf buds. Lane 17, blank.

The gel [Fig. 5] shows that the most DNA came from young leaves and leaf buds. The mature leaves gave a small amount of DNA, whereas the petals did not yield any DNA.

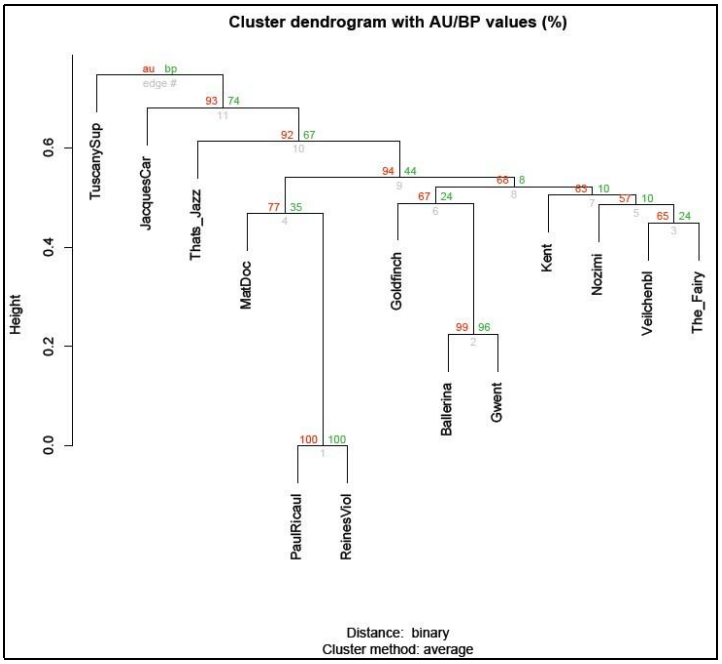


Fig. 6. Cluster dendrogram for the ISSR data. Two types of bootstraps [are] used, approximately unbiased (AU), shown in red and bootstrap probability (BP), shown in green.

The cluster dendrogram [Fig. 6] indicates that the roses do not fall into clusters based on their horticultural type. The relationships do not appear to be based on how the roses are grouped together, with the exceptions of Paul Ricault and Reines des Violettes, which gave identical banding patterns with all primers. It may be that different primers would highlight differences between these roses, or they may have very similar parentage. The origins of many of these roses is unknown, in fact many of them may have hybridised from the same plant at some point in their history. This is being seen by the ISSRs, but was not seen based on their morphological classification. "This project has shown that ISSR-PCR is a very useful method by which diversity between species can be analysed. This is a very fast and easy method to use and gives a meaningful amount of data.

Breeze's conclusion is particularly pertinent to the ongoing research into the parentage of Central Asian rose species, where wild collected seed is being germinated at the field station at Thenford, in preparation for DNA testing, and then analysis of the very young shoots, at the University of Bath. [Case Study 2]

3.12 A new order of phylogeny in the subsections of the genus *Rosa* 2015

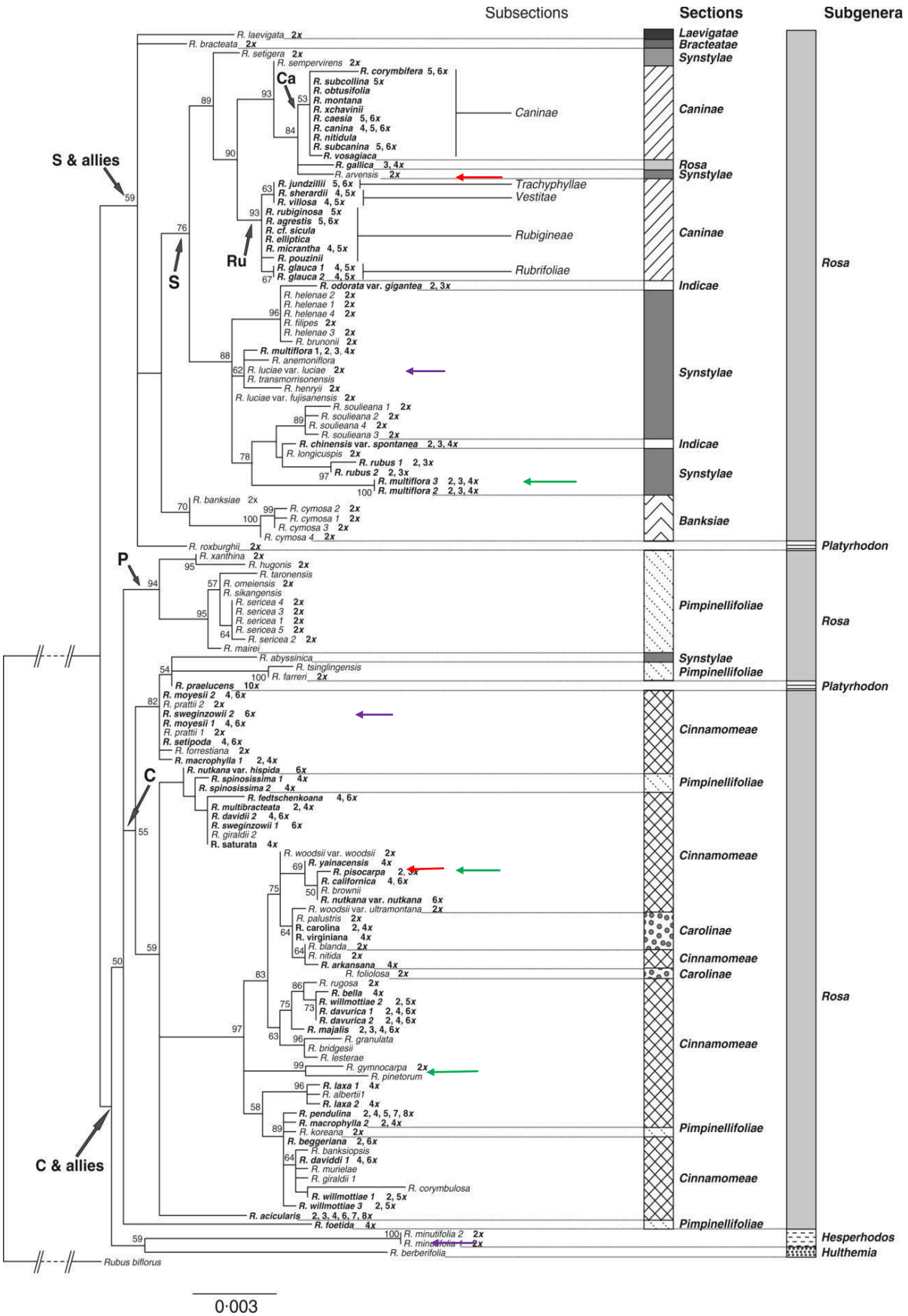
Everything 'changed' with the publication in 2014 of *Phylogeny and biogeography of wild roses with specific attention to polyploids*[lxix] by Fougère-Danezan et al; and with the publication of *Phylogenetic Relationships in the Genus Rosa Revisited Based on rpl16, trnL-F, and atpB-rbcL* by Bruneau, Starr, Joly, Fouge-Danezan, Xin-Fen, and Li-Bing. 2015[lxx]. There have been numerous attempts at building a phylogeny to give a new perspective on the genus *Rosa* using rapidly amplified polymorphic DNA (RAPD) Data but this 2015 paper appears to have superseded all previous work. In brief, the study examines infrageneric relationships with respect to conventional taxonomy, considers the extent of allopolyploidisation, and infers macroevolutionary processes that have led to the current distribution of

the genus. Directions for a new sectional classification of the genus *Rosa* are proposed, and the analyses provide an evolutionary framework for future studies.

Their results [Fig. 8] show that the current distribution of roses from the *Synstylae* lineage in Europe which does not exhibit remontancy is probably the result of a migration from Asia approximately 30 million years ago, after the closure of the Turgai strait. The significance to this thesis is that if the remontancy in the roses of China were to have influenced remontancy west of the Himalayan and Tian Shan mountain ranges over thirty million years ago, that Chinese influence would be evident today in Central Asia and Europe because after that the division of the Eurasian landmass by the Turgai Sea [Fig.7] ((Brinkhuis et al 2006)[lxxi] had the effect of isolating plant populations. (Akhmetie & Beniamovski 2009)[lxxii]. This research found no evidence for any Chinese influence.

[Fig. 7]. The continental configuration during the Early Eocene (49 million years ago) showing the Turgai Strait. (Brinkhuis et al 2006)
The Turgai Sea or Turgai Strait was a large shallow body of salt water, an epicontinental or epeiric sea, of the Mesozoic and Cenozoic Eras. It extended north of the present-day Caspian Sea to the "Paleo-Arctic" region, and was in existence from Middle Jurassic to Oligocenetimes, from approximately 160 to 29 million years ago.
The stars show the distribution of the free floating fern *Azolla,* fossilised forms of which were analysed by the Arctic Coring Expedition, in the course of the construction of this map.

Figure sourced from:
http://theazollafoundation.org/azolla/the-arctic-azolla-event-2/



[Fig.8] **Fig. 8** Phylogenetic relationships among Rosa species (Bruneau et al 2015). Note that neither *Rosa x damascena or Rosa moschata* are included in the table because they are considered to be naturally occurring hybrids. Parents and putative parents of *Rosa x damascena* are highlighted in red. Remontant species are highlighted in green; semi remontant species in purple. Phylogenetic relationships among Rosa species as reconstructed by Maximum Likelihood analyses of three chloroplast regions (psbA-trnHspacer, trnL region and trnGregion). Bootstrap values are placed as close as possible to the node supported. The ploidy

level of each species is given after its name (see Erlanson, 1929, 1934, 1938; Roberts, 1977; Yokoyaet al., 2000; Roberts et al., 2009; Jian et al., 2010). The names of known polyploids are in bold (in R. sect. Caninae all species are presumed to be polyploids even when the ploidy number is not exactly known). Wissemann's (2003) classification is compared with our clades. A P designates ourPimpinellifoliae clade, a C our Cinnamomeae clade, an S our Synstylaeclade, Ca our Caninae clade and Ru our Rubiginae clade.

The work of Bruneau et al (Bruneau 2007)[lxxiii] [Fig.8] published in 2007 demonstrated that phylogenetic analyses of non-coding chloroplast sequences from the trnL-F region and psbA-trnH intergenic spacer for seventy of the taxa, showed slightly more variation than previous analyses of the genus. Bayesian analyses, statistically the most probable, and parsimony, the simplest explanation, suggest that subgenus *Rosa* can be divided into two large clades, each with low internal resolution. One comprises species from sections *Carolinae, Cinnamomeae* and *Pimpinellifoliae* [Fig.8], whilst the other consists of all of the remaining sections of subgenera, *Rosa (Banksianae p.p., Bracteatae, Caninae, Indicae, Laevigatae, Rosa, Synstylae and Pimpinellifoliae* [Fig 8]. Analyses also are consistent with the notion that cultivated commercial roses have a relatively narrow genetic background [p.23]. Six of the seven primary taxa believed to be involved in the creation of domesticated roses, are found within the same large clade that includes most of the Asian and European taxa. (Bruneau, Starr, Joly 2007) As a result, the implications of breeding roses with specific assessions of *R. x damascena* have gained in significance.

3.13 Principal of evidencing botanical point of origins, using plots of overlapping population distributions.

The DNA analysis by Iwata et al (Iwata et al 2000)[lxxiv] demonstrated that *Rosa x damascena* is a hybrid, furthermore a naturally occurring hybrid between three different species. There is precedent for plotting the geographical distribution of parental species of plant hybrids to ascertain approximately where the hybrid originated, that is, its 'point of origin'. (Burbidge 1960)[lxxv](Fidelibus et al 1993)[lxxvi] (Hyatt 1999)[lxxvii] Consequently to validate the point of origin for *Rosa x damascena* it has been important to plot the geographical distribution of the species that DNA analysis has shown to be the parents and to place the species in the context of other species also indigenous to the same geographical area. In short to avoid the prospect of hybridisation by species other than those identified in the DNA analysis, how *R. x damascena* fits into the rose family's local phylogenetic tree. (See Appendix 1. Geographical Distribution of Central Asian Rose species). Prior to Bruneau et al's precise, genetic mapping in 2014, morphological characteristics were the only means of identification. Eighty per cent of the Earth's species are white, cream, blush or pink, and the remaining twenty per cent are split evenly between yellow, red or purple. All rose species bear single flowers comprising five petalled blooms, although four petalled flowers are known to occur sporadically (Harkness 2005)[lxxviii].

Botanically, *Rosa damascena* is a *naturally occurring hybrid*. It is naturally occurring because it was not bred artificially to produce a cultivar. *Hybrids* should not be confused with *cultivars* which are a plant

variety that has been produced in cultivation by selective breeding. It may well be that several thousand years ago man selected the *Rosa x damascena* hybrid from a pool of hybrids growing in the wild, perhaps because they were more fragrant or flowered longer than their wild counterparts. This process is called *domestication*, and is estimated to date back 9,000-11,000 years and in the Neolithic period, took a minimum of 1,000 years and a maximum of 7,000 years (Asano et al 2011)[lxxix].

There has been considerable debate over just how many true rose species exist in the world today because so many are very similar and many could be variations of a single species. The problem has recently been clarified by the work using DNA analysis of Fouge Danaezan which concludes that there are at least one hundred and ninety species in the world (Fouge-Danezan 2015)[lxxx]. Subsequently, the Plant List was updated to include this work. The Plant List a list of botanical names of species of plants originally created in 2010 created by the Royal Botanic Gardens, Kew and the Missouri Botanical Garden in 2010[lxxxi] (discovery. com 2010). The list aims to be comprehensive, and to deal with all known names of plant species (Index Kewensis, 2004)[lxxxii]

3.14 Remontancy

This thesis evidences that the *Rosa x damascena* that was present in Classical Rome, was remontant. This was a surprising revelation because, or so it was thought, remontant roses did not appear in Europe until the 18th Century. Furthermore, it was thought that the remontant gene originated in China, and only arrived in Britain by the late eighteenth century. Remontancy is defined as the ability of a plant to flower more than once during the course of a growing season or year. It is a term applied specifically to roses, and roses possessing this ability are called remontant. The horticultural terms "repeat flowering" and “recurrent” are used synonymously in gardening circles.

Although molecular mechanisms regulating the flowering process have been extensively studied in annual plants and in perennials, the understanding of the molecular mechanisms controlling flowering in *Rosaceae* has only just started to emerge.

3.15 Recent research on remontancy in roses. Two seminal papers:

Researchers from the Genetics and Horticulture Unit in Angers, including Hikaru Iwata who was one of the team who discovered the parentage of *Rosa x damascena*, demonstrated in 2011 the presence of a repressor gene belonging to the *TFL1* gene family (TERMINAL *FLOWER 1*).

Meanwhile, researchers at the fruit species research station in Bordeaux showed that the flowering rise in the strawberry *Fragaria vesca* is due to a mutation of the same repressor gene. This mutation appeared in the Alps in wild strawberries and was subsequently selected by humans.

The work published in 2013 of the INRA teams in Angers-Nantes and Bordeaux-Aquitaine explained the phenomenon of the rising flowering of the rose and of a very close plant, the strawberry, belonging to the same *Rosaceae* family. In rosier (genus *Rosa*), after the first spring flowering, this repressor expresses and

prevents any new flowering in non-rising roses. However, the protein corresponding to this repressor gene is not produced by the rising roses because of a genetic mutation that would have appeared in wild Chinese roses, *Rosa chinensis* var. *spontanea*.
In the long term, new genetic selection strategies to trace old varieties of non-rising roses could be developed. Studies in progress will also make it possible to specify the importance played by this gene in the history of the selection of the rose bush by the man.

The TFL1 homologue KSN is a regulator of continuous flowering in rose and strawberry[lxxxiii]

The collaborative research published in *The Plant Journal, 2011*[lxxxiv] by Hikaru Iwata, Amélia Gaston, Béatrice Denoyés Takashi Araki , Arnaud Remay, Tatiana Thouroude, Julien Jeauffre; Saint Oyant and Fabrice Foucher demonstrates that flowering is a key event in plant life, and is finely tuned by environmental and endogenous signals to adapt to different environments. In horticulture, continuous flowering (CF) is a popular trait introduced in a wide range of cultivated varieties. It played an essential role in the tremendous success of modern roses and woodland strawberries in gardens. CF genotypes flower during all favourable seasons, whereas once-flowering (OF) genotypes only flower in spring. Here we show that in rose and strawberry continuous flowering is controlled by orthologous genes of the *TERMINAL FLOWER 1* (*TFL1*) family. In rose, six independent pairs of CF/OF mutants differ in the presence of a retrotransposon in the second intron of the *TFL1*homologue. Because of an insertion of the retrotransposon, transcription of the gene is blocked in CF roses and the absence of the floral repressor provokes continuous blooming. In OF-climbing mutants, the retrotransposon has recombined to give an allele bearing only the long terminal repeat element, thus restoring a functional allele. In OF roses, seasonal regulation of the *TFL1* homologue may explain the seasonal flowering, with low expression in spring to allow the first bloom. In woodland strawberry, *Fragaria vesca*, a 2-bp deletion in the coding region of the *TFL1* homologue introduces a frame shift and is responsible for CF behaviour. A diversity analysis has revealed that this deletion is always associated with the CF phenotype. Our results demonstrate a new role of *TFL1* in perennial plants in maintaining vegetative growth and modifying flowering seasonality.

RoKSN, a floral repressor, forms protein complexes with RoFD and RoFT to regulate vegetative and reproductive development in rose (Foucher, Hybrand & Denoyes 2013)[lxxxv]

FT/TFL1 family members have been known to be involved in the development and flowering in plants. In rose, RoKSN, a TFL1 homologue, is a key regulator of flowering, whose absence causes continuous flowering. Our objectives are to functionally validate RoKSN and to explore its mode of action in rose. We complemented Arabidopsis tfl1 mutants and ectopically expressed RoKSN in a continuous-flowering (CF) rose. Using different protein interaction techniques, Foucher *et al*[lxxxvi] studied RoKSN interactions with

RoFD and RoFT and possible competition. In Arabidopsis, RoKSN complemented the tfl1 mutant by rescuing late flowering and indeterminate growth. In CF roses, the ectopic expression of RoKSN led to the absence of flowering. Different branching patterns were observed and some transgenic plants had an increased number of leaflets per leaf. In these transgenic roses, floral activator transcripts decreased. Furthermore, RoKSN was able to interact both with RoFD and the floral activator, RoFT. Protein interaction experiments revealed that RoKSN and RoFT could compete with RoFD for repression and activation of blooming, respectively. We conclude that RoKSN is a floral repressor and is also involved in the vegetative development of rose. RoKSN forms a complex with RoFD and could compete with RoFT for repression of flowering.

Seasonal regulation of the TFL1 mRNA level

The genetic basis for remontancy, the regulation of seasonal flowering in the *Rosaceae* (Kurokura, Mimida, Battey,Hytönen 2013)[lxxxvii] and the regulation of flowering by temperature, and photoperiodic flowering still remains poorly understood. (Bradford, Hancock 2010)[lxxxviii]

Rose species have been used to illustrate how photoperiod and temperature control seasonal flowering in rosaceous crops. Recent molecular studies have revealed that homologues of *TERMINAL FLOWER1* (*TFL1*) are major regulators in all stages of growth from juvenile to the adult plant, and also the vegetative to reproductive transitions, in various rose species. In the rose species tested so far, the expression maxima of *TFL1* mRNA is detected in the vegetative SAM, the Shoot Apical Meristem, whereas it's down-regulation precedes flower initiation. These exciting new developments suggest the seasonal regulation of the *TFL1* mRNA level is a key mechanism, in periodic floral development in rose species.

3.16 Remontancy in the wild was not thought to show over lapping distributions in Central Asia and Europe.

Until 2010 most of the speculation surrounding remontancy was based on the claim that the only truly remontant rose species were geographically distributed through Japan, China, and the Tien Shan and the Palmir-Alai, the mountains extending into North West China. All deciduous, these remontant species found in the wild are:

Rosa chinensis **var. spontenea**[Fig.9]

[Fig.9] *Rosa chinensis*

Rosa chinensis (Chinese name: 月季, pinyin: yueji), known commonly as the China Rose , a native of Southwest China in Guizhou, Hubei, and Sichuan Provinces. The species is extensively cultivated as an ornamental plant in China, and numerous cultivars have been selected, now known as the 'China' roses. It has been extensively interbred with *Rosa gigantea* to produce *Rosa × odorata*, and by further hybridisation, the Tea roses and the Hybrid Tea roses, the bedding roses known to Western gardening

Rosa fedtschenkoana [Fig.10]

[Fig.10] *Rosa fedtschenkoana*

Discovered in 1871, a native of the Amu Darya watershed [pp. 38-42] the Tien Shan, and the Pamir-Alai, extending into North West China. Deciduous, forming a bushy and suckering shrub up to 2.5 metres high and as much across. The remontant flowers are white, up to 5 cm across, and are borne singly, or in small clusters, at the tips of the branches. The flowers 'scent like blackberry jam'. Flowers are followed by small, pear- shaped, bristly orange-red fruits.

Rosa rugosa [Fig. 11]

[Fig. 11] Rosa rugosa

A remontant species native to eastern Asia, in north-eastern China, Japan, Korea and south-eastern Siberia, where it grows on the coast, often on sand dunes. The flowers are strongly scented, dark pink to white (on *R. rugosa* f. *alba* (Ware) Rehder), 6–9 cm across, with somewhat wrinkled petals. The early season flowers are followed hips are large, 2–3 cm diameter, and often shorter than their diameter, rather than elongated. In late summer and early autumn, the plants often bear fruit and flowers at the same time. The leaves typically turn bright yellow before falling in autumn.

As explained above, the genetic basis for remontancy, the regulation of seasonal flowering in the *Rosaceae* and the regulation of flowering by temperature, and photoperiodic flowering remains poorly understood. Nevertheless, there is some evidence to show that remontancy is a means of survival for roses that come under threat, for example, from dire climatic conditions of heat or aridity. Recent research by (Remay 2009)[lxxxix] and our own research on Mattock's nurseries at Lodge Hill, and at field experiments at Thenford have shown that additionally at least two, possibly five more species from Central Asia display remontancy as they mature. The two principle candidates are as follows:

R. webbiana [Fig.12]

Species rose from the *Cinnamomeae section*, Webb's Rose [Fig.12] is a common shrub rose, widely distributed, growing from 1500 metres up to 4000 metres. A shrub of 1-2 m high, with straight, slender, yellowish prickles. Leaflets 5-9, obvate or almost round, obtuse, grey-blue. Flowers are born singly, usually pink, with a white centre and are scented. Hips are bottle-shaped to globular, and red. The rose is native to the western Himalayas from the Pamir in central Asia to Kashmir, Tibet and Afghanistan.

[Fig.12] *R. webbi*ana

[Fig.13] *Rosa beggeriana*

[Fig.14] *Rosa beggeriana* Hips

Rosa beggeriana [Figs 13 & 14]

Distribution: Iran, Afghanistan, Kyrgyzstan [Fig.14], Pakistan (N. Baluchistan, Chitral, Gilgit, Swat), Kashmir, India (Uttar Pradesh).

A composite and very variable species, especially in the type of indumentums, the hairs or down on the stem or leaf. In spite of its variability the species is very easy to recognise by its small fruits. The sepals are often deciduous. The top of the hypanthium is yellowish, and the stems are covered with curved and uniform prickles. The plant bears white, rather small flowers, [Fig.13 & 14], grossly serrate leaflets, and green, often slightly glaucous, stems. *Rosa beggeriana* hybridises freely with *Rosa webbiana*, the introgression between these species seems to be common in many regions. Introgression is the transfer of genetic information from one species to another through hybridisation or back crossing. Supposed hybrids and introgressants can be usually recognized by pinkish flowers, and less curved or straight prickles, and larger fruits. Cultivated as an ornamental plant, its small petals are rich in ascorbic acid.

Cladistics

Note that *Rosa beggeriana* is considered to be a composite species. The concept of the composite species concept is an attempt, by Dina Kornet (Kornet 2005)[xc], to define species cladistically. A species, in this definition, is a segment of a lineage in which a new character state becomes fixed, from the point where it arises, by cladogenesis, to the point where a new lineage, in which another character state, becomes fixed. In cladistics, it is the derivation of new taxa that occurs through the branching of ancestral lineages, each such split forming two, possibly more, equal sister taxa, that are often considered taxonomically separate from the ancestral taxon (Dictionary of Zoology 2016)[xci] The proper elucidation of character states, in this case remontancy, and their polarity, is one of the major concerns of cladistic analysis.

3.16 Potential for remontancy in further Central Asian Rose Species

This potential has been under-researched. This thesis is particularly concerned with concerned with doubt raised by Cirigan (Ciragan 2014)[xcii] who disagrees with the parentage of *Rosa x damascena* as defined by Iawata et al (Iawata et al 2000)[xciii]. [see Chapter 8. *Discussion*] The doubt has given impetus to an ongoing study into whether remontancy exists in other Central Asian Rose Species [Fig.15], to ascertain whether there are other remontant candidates for the parentage of *R. x damascena.* The initial results of this study are considered in [Chapter 8] the *Discussion*, and are the subject of the table in Appendix (1.) To put the issue into context a table has been constructed of the rose species found in Central Asia listed under their *Accepted Name,* together with their *Synonym*s, and geographical distribution by country. This is important because in an area as extensive as Central Asia, populated by a myriad of different peoples, all speaking different languages, names of plants are apt to become confused. One people referring to a plant as one name, another people using that same name for a different plant and so on. The problem is exemplified in *Rosa canina*. Known as the Dog Rose in Britain it is also known by a further 168 synonyms across its distribution that extends from Britain, Europe, North Africa, the Middle East and Central Asia. Essential to this thesis is the ability to definitively identify a plant, *Rosa x damascena*, with just one name, over a geographical area of twenty-one countries and regions, each one of which has its own synonym or synonyms for the same rose.

The Accepted Name is the name which should be used to refer to the species, or to a subspecies, a variety or a form, as pronounced by The Plant List.[xciv] (Plant List 2013) *The Plant List*, referred to earlier, provides the Accepted Latin name for most species, with links to all *Synonyms* by which that species has been known. It also includes *Unresolved* names for which the contributing data sources did not contain sufficient evidence to decide whether they were Accepted or Synonyms, or where there were conflicting opinions that could not be readily resolved. (Plant List 2016) [xcv]

3.17 Case Study 2.

Research into the evolutionary genetics, the remontancy, the taxonomy and the geographical distribution of *Rosa x moschata*, *Rosa abyssinica* and *Rosa phoenicia* and allied Central Asian Rose Species; and reintroducing the Syrian Damask into Syria.

There is no definitive collection of rose species in Europe, and in consequence, in an attempt to resolve the taxonomic complexities Central Asian Rose Species described above, a living collection of wild collected rose species, the *Mattock Heseltine Rose Species Collection*, is being established at Lord Heseltine's garden and arboretum at Thenford, near Banbury in Oxfordshire. [Fig. 15]. The rose species are being sourced from plant hunters from around the world. Already collections of historic cultivars have been sourced variously (from propagating material in the form of soft and hardwood cuttings and seeds) from the Mattock Family Collection, the Heseltine Collection, the Royal National Roses Society's garden at St. Albans, from Kew Botanic Gardens, RHS Wisley and from propagating material in the form of soft and hardwood cuttings and seeds, sourced from plant hunters from across Central Asia.

[Fig. 15]. *R. webbiana* [NURSB5] in flower at Thenford for a second time late July 2015

Table 1. gives an introduction to the complexities of the taxonomy, and the identification of the Geographical distribution of the Central Asian Rose Species This study is particularly concerned with the parentage of *R. x damascena*, which post Iwata *et al* in 2000 was thought to be *R. gallica*, *R. moschata* and *R. fedtschenkoana*.

A second hypothesis, that *Rosa phoenicia* is a parent of *Rosa x damascena* was dispelled by John Philips and Martyn Rix in their *Ultimate Guide to Roses p.19 (*Philips & Rix 2004*)* in light of recent DNA studies by Iawata et al. However, clarification by DNA analysis of both *R. x moschata* and *R. phoenicia* is required to determine the phylogenetics of these two species and whether they are both one and the same, or alternatively a parent, or a variety, or a form of one or the other. Certainly both R. *moschata* and *R. phoenicia* belong to the same subsection of the genus Synstylae in which the scent emanates from the stamens, not from the petals.[xcvi]

In the light dispute from Ciragan and Louette (2014) and Remay (2011) over the validity of Iawata's work, it appears appropriate to include *R. phoenicia, R. brunonii, R. moschata nepalensis, R. beggeriana, R. brunonii, R. moschata. R. ruscinonesis, R. abysinica, R. freitagii, R. godefroyne, and or R. sambucina* and *R. webbiana,* in the study. Investigation into the overlapping forms of these Asian climbing rose species requires laboratory analysis to confirm, or not, previous morphological identification.

Seed and propagating material from the wild collected plants is grown on, to produce material for the DNA sequencing required, to determine the phylogeny of these difficult taxonomic individuals.

As mentioned earlier, of particular significance to this study is the ability to be able to observe, and experiment, on plants that have been established from material collected in the wild. It has been found that much of the material sourced from gardens, nurseries and botanic gardens have been infected by hybridisation, because the genus *Rosa* is particularly promiscuous. Plants have been established at Thenford for some twenty years sufficient to be able to collect leaf material from an extensive range of assessions, in preparation for DNA sequencing by commercial laboratories late this spring/early next summer, depending on the weather and plant growth. The research programme is being established, using wild collected plants, aimed at determining if there was ever an original *R. moschata* species, the Musk, or whether as historic Iranian and Arabic texts indicate these different forms are all of Chinese hybrid origin.

Alongside the project involving the *Musks* we are looking at the status of the composite *R. webbiana*. Already, a series of assessions of wild selected plants have been established. An early success has been in one specimen of *R. webbiana.* [NURSB5] This plant came into flower a second time in 2015 [Fig. 97.] The plant is some five years old, and is grown outdoors but protected from wind and sun. Over the last eighteen months a germination unit has been built at Thenford, where a nursery already exists, to accommodate seed and cuttings that are being exchanged with other collections, or that are being collected by plant hunters on the study's behalf.

Following the results of DNA sequencing in 2000 by Iwata et al (Iwata et al 2000) [xcvii] who established that *R. gallica*, *R. moschata* and *R. fedtschenkoana* are parents of *R. x damascena,* further research is required. One to ascertain the parentage of *Rosa moschata which is* thought to be a naturally occurring hybrid and two whether *Rosa phoenicia and/or Rosa abyssinica* are alternative or additional remontant parents of *Rosa x damascena* in the Levant. particularly in Syria and the Levant as some authorities would have us believe (Pal 2013)[xcviii] Syrian rose oil is held to be the finest (Bilal 2016) [xcix] the question is why. Case Study 2 brings to gather ongoing research into the phylogeny of Central Asian rose species with new research into whether *R. phoenicia* is a Syrian *R. x damascena* parent, and whether it is *Rosa phoenicia* that make the Syrian rose oil so special is the subject of further research [p.150].

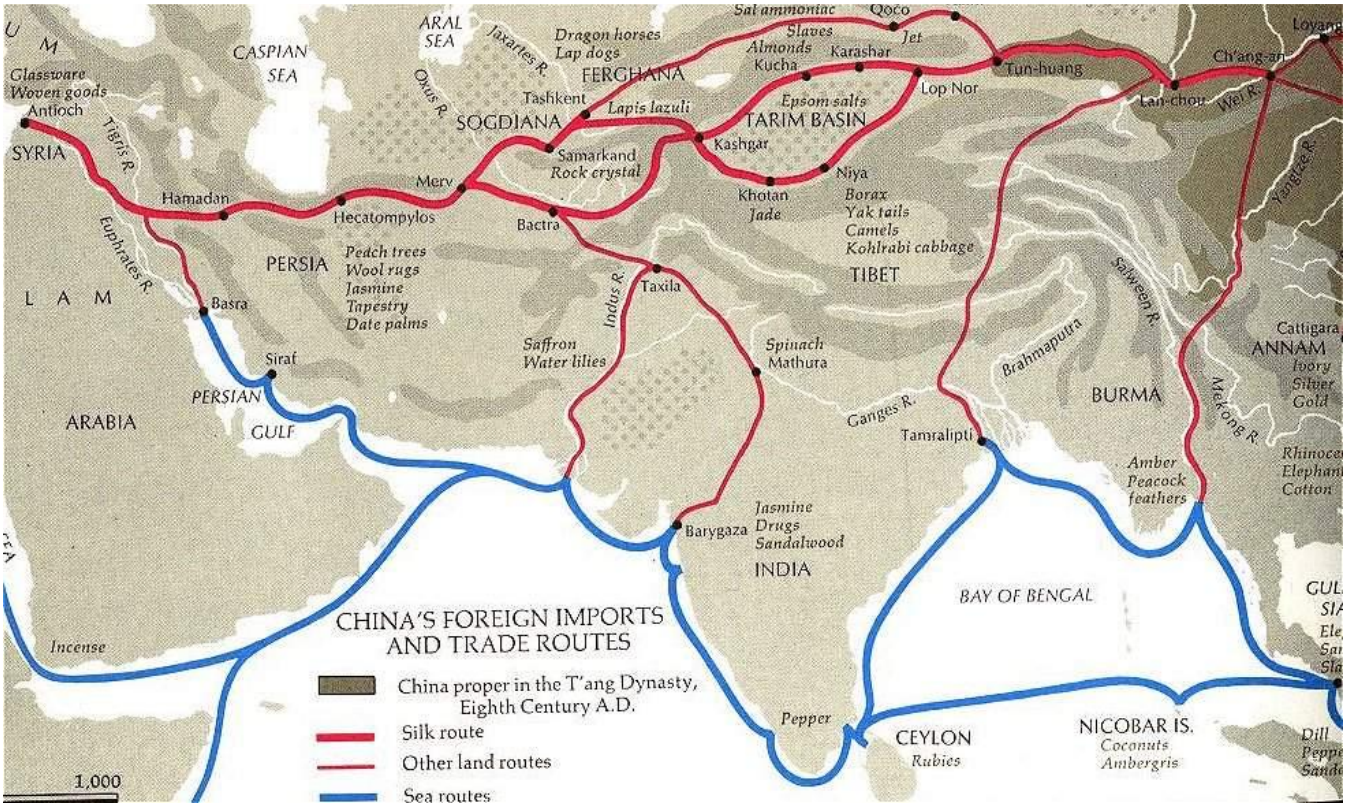
[Fig. 16] The Silk Road Hybrids – Central Asia
The geographical area of interest to those collecting rose seed/rose hips of Central Asian rose species for the study on their Evolutionary Genetics and Taxonomy.

3.18 The Silk Road and the Chinese equation.

Did remontant Chinese hybrid roses, transmigrate along the Silk Road?

When research towards this thesis began in 2008, it was generally acknowledged that there were no remontant species with distributions that overlapped geographically with the two stud parents, *R. gallica* and *R. moschata*. Consequently, research was conducted into how Chinese species, hybrids or cultivars might have been transported by man along the trade route leading from China to Rome, The Silk Road. A considerable body of research was amassed over a period of three years, seeking to demonstrate that the remontant gene transmigrated along the Silk Road [Fig.17] to the West, because it been generally assumed in the horticultural world, that the remontant gene originated in isolation, in China, and only arrived in Western Europe with the four Stud Chinas in the eighteenth century [p.50]. In the face of more recent research it could appear that this research was wasted because it was later found that the remontant gene in *R. x damascena* did not originate in China. However, important facets of the initial Chinese research remain significant to this thesis, particularly in respect of Islamic expansionism, and how the Moslems extended the range of rose water usage. To that end the research is detailed in Appendix 2. and summarised below.

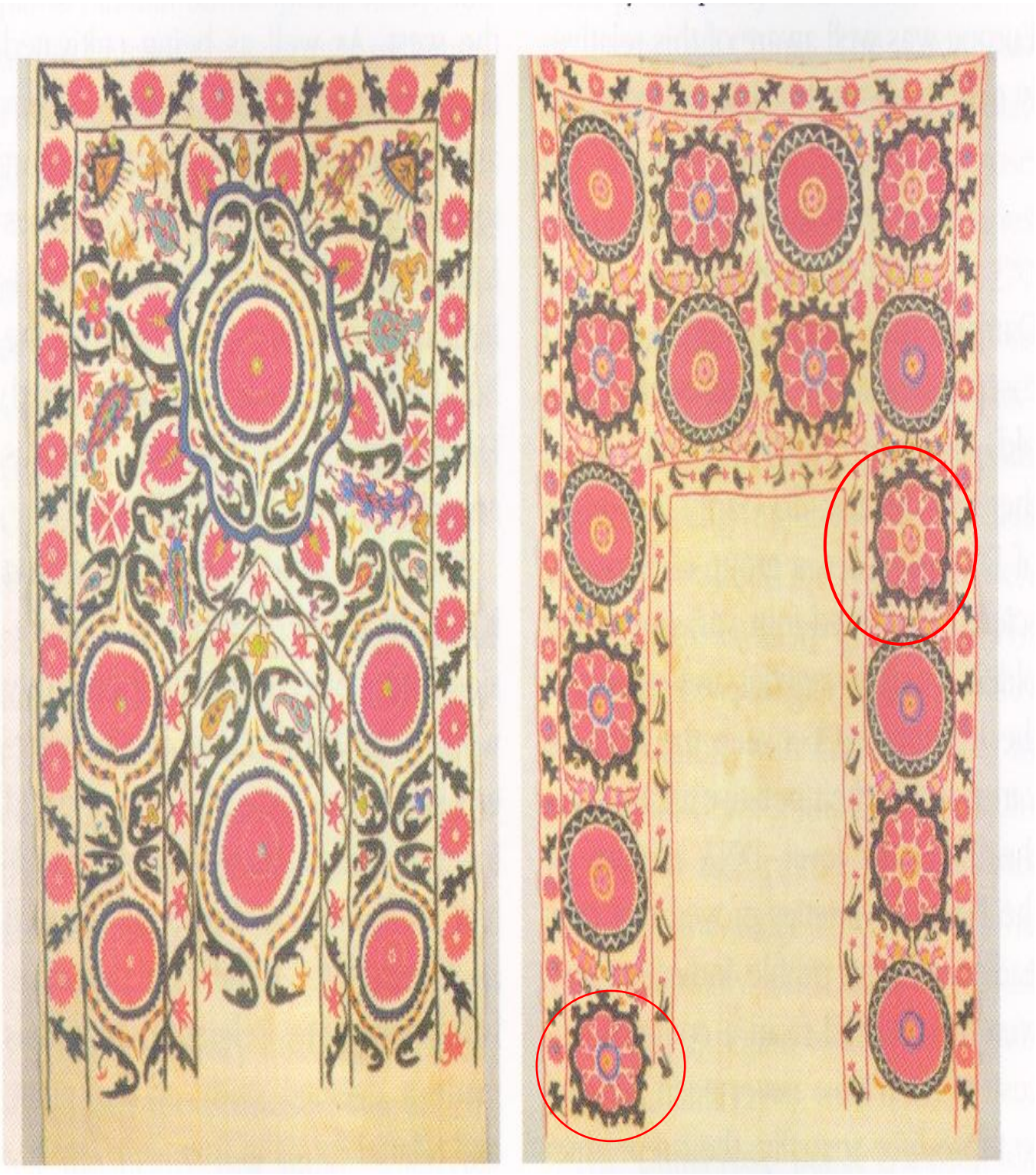
A seemingly obvious answer to how the remontant gene transmigrated from China was that it was carried by merchants along the Silk Road and its artery the Royal Persian Road [Fig.17]. The Silk Road had long been thought to be an ancient trade route between China and the Mediterranean Sea. It extended some 6,440 kilometres, linking China with the Roman Empire from the 2nd century B.C. to the 14th century A.D., facilitating traffic in both directions. (Wood 2004)[c] What was man's incentive for travelling 8,000 miles over some of the most inhospitable terrain in the world just to find a rose? Could it have been that affluent gardening enthusiasts, gardening celebrities of the classical world sought garden novelties to show off to their horticultural peers and to breed new strains of colour, fragrance or growing habit into their indigenous stock? Did they send envoys off to China to collect their rose order for remontancy? It is an appealing and easily understood proposal amply supported by the accounts of Victorian archaeological travellers describing the heroics of medieval merchant traders traversing the rugged terrain. However, while there is strong documentary and illustrative evidence of sophisticated cultivars being grown in China during the Classical period, there is no evidence of those hybrids being grown in Europe at that time. Research into the possible passage of such hybrids from the evidence of stylised patterns on Central Asian rugs; into motifs on porcelain and ceramics found in the Taklimakan Desert; into the head dresses of Hindu gods and goddesses, resulted in nothing of substance to evidence distant transmigration from China to Rome.



[Fig.17] China's historic foreign imports and trade routes. Note the two areas on the Silk Road, the Tarim Basin and Samarkand where trading posts with their courtyards gardens were established. Traders operated between these posts rather than along the route as a whole.

Pattern Recognition

Iconographic evidence in the form of 'Pattern recognition' for Silk Road Hybrids, was investigated by looking for roses and stylised roses in objects such as paintings, rugs, carpets, mosaics and wall hangings. [Fig. 17] Archaeologists and art historian are skilled at dating such artefacts. It is useful to know when conducting a search for depictions of wild roses, that species roses normally have single, five petalled flowers, and only hybrid roses have double flowers. No carpets were found depicting roses but blankets from Uzbekistan depict roses and ornament from Persia depicts the Damask rose. [Figs. 18 & 18b]



[Fig.18] Fourteenth century 'Shahr-I-Sabz work' on an embroidered blanket depicting Gul farangi. (Rosettes) From Kalter, Johannes & Pavalot, Margareta Uzbekistan. Heirs to the Silk Road (H. Mayer 1979)

Plate XLVII. PERSIAN ORNAMENT.

[Fig. 18b] Persian Ornament[ci] 1868 Owen Jones Ornament Print Persian No 4. From a Persian Manufacturers Pattern Book Kensington Museum

Note the highlighted plants, both exhibiting rose foliage and double pink flowers, conclusive identification of the rose.

In the light of (Leslie & Gardener 1996)[cii] it is unsurprising that Chinese hybrids were never found in Rome because, they claim, the Chinese never made it to Rome. The *Hou Hanshu*, the Chinese history of the later

Han Dynasty (CE 25-220), explains that "Gan Ying was a Chinese military ambassador who was sent on a mission to Rome in 97 CE by the Chinese general Ban Chao (32-102CE).

Gan Ying never reached Rome, only travelling to as far as the "western sea" which either refers to the Black Sea or the Parthian coast of the Persian Gulf. However, he is, at least in the historical records, the Chinese who went the furthest west during antiquity. (Leslie & Gardener 1996)[ciii] (Hill 2003)[civ]

3.19 The Four Stud Chinas - Long held beliefs on remontancy

Meanwhile the only Chinese roses known to have migrated from China to Western Europe were transported by sea in the 1790s. Until recently, the long held belief in the West was that the much desired characteristic of remontancy displayed in western garden roses, owed its occurrence to hybridisation between European roses and a group of remontant roses from China, the so called Stud China Roses. These *Rosa chinensis* hybrids which were transported from China by sea, and introduced in to Great Britain between 1792 and 1824. They have been extensively credited with being the source of remontancy in the breeding of European garden roses. This thesis disproves that conjecture.

Certainly the four Stud Chinas caused a huge change in the variety and characteristics of the Gallica and Damask gene pool, allowing for the creation of new and exciting roses. The arrival of the China rose changed the rose world profoundly. In the first edition of *"The Rose Garden,"* written by William Paul (1822-1905) in 1848[i], he recorded 741 French rose varieties, 87 Gallica varieties and only 106 China rose varieties. By 1872, in the third edition of "The Rose Garden," Paul recorded only 18 French rose varieties, only 10 Gallica varieties but a huge increase to 538 China rose varieties, indicating that China rose was pivotal in hybridising roses during that time.

During this period that the Four Stud China roses were influential in Europe, Dr. Hurst, a Cambridge cytologist and author of *'Notes on the Origin and Evolution of our Garden Roses'*1941[ii] determined that three of the four stud roses were hybrids of the two wild-sourced species, *R. odorata* and *Rosa chinensis* Var. *spontanea.* The odd one out was 'Slater's Crimson China', that he determined to be solely derived from *Rosa chinensis var. spontanea*. [Figs. 18, 19, 20]

a) 'Slater's Crimson China' was imported by Gilbert Slater of Knot's Green, Leytonstone in 1792, and by 1798, the French, who dominated rose breeding efforts at the time, had begun hybridisation experiments. It is perennial flowering, has a dwarf habit, and has semi double flowers.
b) Parsons' Pink China: It is generally accepted that the pink China rose which transformed the world's roses came to Europe via Sweden in 1752. The first mention in England came in 1771 when William Malcolm [iii] included it in his nursery list 'Evergreen Chine' and 'a new Chine'.
c) 'Hume's Blush Tea-Scented China was introduced by Sir A. Hume from the "East Indies" (then including China) in 1810. It was originally named *R. indica odorata* and later *R. indica fragrans*. It is known for its large, elegant, pale pink flowers that bloom continually. It is said to have survived arduous conditions upon importation, with only 1 in 1,000 plants surviving first the voyage from China, having been exposed on the ship's open deck, and then to an English blockade of French ports during the Napoleonic Wars.

d) 'Parks' Yellow Tea-Scented China' was brought to the Royal Horticultural Society in 1824, having probably arrived from China in 1823. Like Hume's China rose, it was more heavily influenced by the Tea rose parent, featuring large yellow flowers with thick tea-scented petals and bright green leaves. It was an important ancestor to many yellow Tea roses of the 1800s.

[Fig. 19] Parson's Pink China (1793) With Slater's Crimson China' (1792)

[Fig. 20]. Hume's Blush Tea Scented China 1752

[Fig.21]. Park's Yellow Scented Tea 1824

3.20 Commercial Exploitation of the Damask Rose in 2016

Comparative study of commercial rose production in 2016 in Western Europe and Iran.

It is a useful generalisation to say that the large headed, very fragrant forms of rose originate from Central Asia, whilst those with high pointed classically shaped flowers, so typical of the cut flower industry, originate from China. In the West we are inclined to view the rose primarily as a garden plant, with but a passing acknowledgement, that the rose makes an important contribution to the cut flower industry. The West makes almost no recognition of the role that the Damask rose plays in the production of rose water. In fact, the commercial production of roses for their fragrant oils is hardly known in the West, and ignorantly so, because the Damask is a major horticultural crop in Bulgaria, Turkey, Iran, India, China, Syria, Morocco and Egypt. The following table serves to illustrate the point. Note that the financial value of the production of *R x damascena* in Iran for rose water, where the commercial production of the rose as a garden plant is almost unknown, is approximately the same as the sales revenue from garden roses in the U.K. [Table 3] FloraHolland at Aalsmeer is the largest trading centre for plants and flowers in the world. (Banks. ADHB.2016)[cv]. Iran produces 90% of the world production of rose water. (pRESS TV)[cvi] The U. K. buys more garden roses per person than any other country in Europe. (Horticultural Week 2016)[cvii]

		U.K.	Holland	Iran
Garden Plants	Quantity (plants)	8,000,000		-
	Value €	42,000,000		-
Cut Flower	Quantity (stems)	256,000,000	2,336,000,000	-
	Value €	64,000,000	584,000,000	-
Rose Water	Quantity (litres)	-	-	224,031,000
	Value €	-	-	40,325,580
Supply of global demand				90%
Export of rosewater 2016				1.88 million litres
Currency revenue 2016				2,162,649 €

[Table 1] Comparative values for the production of garden plants in the U.K. against *R x damascena* production in Iran.201

Garden Roses

Based on a survey by Ipsos Mori for the HTA in 2011, when they asked how many people have roses in their garden? 49% of people, who have somewhere to grow outdoor plants, responded that they grow roses. Some eight million roses are grown in the U.K. each year now in 2015/6 compared with fifteen million in the late 1990s, twenty-five million during the late eighties and seventy-five million during the sixties and seventies. Despite the drop in production the garden rose is still the nation's favourite flower, according to the British Association of Rose Breeders (BARB). A difficult figure to evaluate, but by looking at the parentage of five hundred of the best known rose varieties on sale in 2015, the author estimates that the influence of the Damask rose on the breeding of today's garden roses in the West amounts, to 20% of the genotype.

The role of the Damask rose in U.K. rose breeding and production in 2016

Post the establishment of the Damask in Rome, the rose has been used extensively in rose breeding in Western Europe to produce a series of stable of ornamental garden varieties. From the eighteen and nineteenth centuries despite the Stud Chinas arriving in Britain from China, the Damask has maintained its influence to the present day, culminating in an enormously successful strain bred in the U.K. by David Austin, that he calls 'English Roses'. There are two naturally occurring species hybrids known throughout the Western gardening world today as the Damask Roses. They are the Autumn Damask, *Rosa x damascena* var. *semperflorens* (Poir.) allegedly brought to Britain by Thomas Linacre, the then Royal Physician after his sojourn in Italy in the 1490s. Secondly, the "Summer Damask", *Rosa x damascena* var. *bifera* which was established in gardens in Italy, France and Germany by 1520, The Autumn Damask, *Rosa x damascena* var. *bifera* has been enthusiastically sought after by western gardeners because of its remontancy, its ability to flower well into the autumn as well as during the summer. Actually it is a poor garden plant being of thin, lanky, rather open growth but it is justifiably grown for its fragrance which is strong, sweet and wonderful. It is known by many names including "Quatre Saisons, Tous les Mois, York and Lancaster. Four Seasons Rose, Monthly Rose , Perpétuelle semi-double, Quatre Saisons, Red monthly, *Rosa italica* Ferrari, *Rosa menstrualis*,

Rose de Castile, Rosier du Calendrier, Royal Four Seasons and The Mission Rose. The Damask has been the subject of rose breeding or selection over the last five centuries resulting in many improved forms, among them 'Celsiana', 'Ispahan', 'Rose de Resht', 'Quatre Saisons Blanc Mousseaux' or 'Perpetual White Moss' or 'Rosier de Thionville' the rose from the specialist breeder in Thionville (France) 1829 (Baudino 2006)[cviii] David Austin has provided the following photographs which illustrate the best of the Damask roses currently in commerce [Figs. 22-30].

Fig. 22. Celsiana Spanish Netherlands. (c.1750 Thory. Spanish Netherlands)

Fig. 23. Gloire de Guillian (Lindsay Hilling 1949)

Fig. 24. Hebe's Lip syn. 'Rubrotincta' (Britain. Lee 1846)

Fig. 25. Ispahan (Intro. 1832) from Persia)

Fig. 26. Kazanlik (1689) One of an old group of plants grown for rose oil.

Fig.27. Leda syn. Painted Damask (1827)

Fig.28. Marie-Louise (France1811)

Fig.29. Mme. Hardy (France 1832)

Fig.30. Omar Khayyam (Britain 1893)

Notes on the origin of 'Gloire de Guillian'

There is some debate in respect of the origin of 'Gloire de Guillian'. Nancy Lindsay claimed that she found the plant in North Iran when at the time that she was seen whilst 'resting' in Paris. Whether she was in Paris or Iran anecdotally she was being assisted by a young Arabian gentleman in her search.

Notes on the origin of 'Kazanlik'

Kazanlik synonym *R. damascena trigintipetala*. Historically it is believed that *Rosa x damascena* was brought to the Kazanlik area (located in the Valley of the Roses) from Tunisia in 1420 by a Turkish judge. At that time that part of Bulgaria was part of the Turkish Empire and the love of the rose had been well established in the hearts of the people of that region over several centuries. White Lotus Aromatics Newsletter Article (website) (Dec 2000)

Graham Stuart Thomas wrote [xlviii], "The 'Kazanlik' rose, too, had been a mystery to me for years. I had received no fewer than three distinct roses under this name: one was a Gallica, one turned out to be 'Ispahan', and a third was identical with another rose I had been given labelled 'Professeur Émile Perrot'. This proved to be the real rose from Kazanlik, *Rosa damascena* 'Trigintipetala', the rose grown in greater quantity than any other in Bulgaria for the production of "attar". It is a similar type to York and Lancaster, *R. damascena* 'Versicolor', with spindly growth up to 6 feet or so, soft light green leaves, and rather small flowers, loosely double, of soft pink. In spite of its name this rose, over here at least, seldom has as many as thirty petals. Through the kindness of Professor V.M. Staicov of the Bulgarian State Agricultural Institute for the Investigation of Medical and Aromatic Plants, who kindly sent me both herbarium specimens and, later, living material of the roses grown at Kazanlik, I have been able to elucidate the matter. ...*Rosa damascena*. This appears to be almost if not quite identical with my *R. damascena* 'Trigintipetala'.

Iwata *et al*. (2000) analysed two Summer Damask varieties ('Kazanlik' and 'York and Lancaster') and two Autumn Damasks ('Quatre Saisons' and 'Quatre Saisons Blanc Mousseux') and found no difference in their DNA profile using 24 RAPD primers. Agaoglu et al. (2000) found no difference among accessions of *R. damscena* plants in Turkey using RAPD markers. Baydar et al. (2004) demonstrated that 15 *R. damascena* plants brought from 15 different plantations in Isparta province, which is the main rose growing region in Turkey, possess identical genotypes based on AFLP markers and nine microsatellite loci. Rusanov aet al. (2005a) characterized a total of 40 Damask rose accessions of which 25 originated from Bulgaria (the collection of the Institute of Roses and Aromatic Plants, Kazanlik) using microsatellite markers derived from *Rosa wichurana* and *Rosa hybrida*. The results showed that all analysed 'Triginitipetala' accessions and the old garden Damask rose varieties 'York and Lancaster' and 'Quatre Saisons' (in confirmation of Iwata *et al*. 2000) possess identical genotypes. In Iran more than one genotype was found, but the genotype in the main

production area was identical to 'Trigintipetala' (Babaei et al. 2007). In conclusion, it appears that the industrial production of rose oil in Bulgaria, Turkey, and to a great extent in Iran is based on a single genotype (and mutants thereof)….

The studies of Babaei et al. (2007) and Kiani et al. (2008) identified non-'Trigintipetala' genotypes, mostly in the mountainous north-western part of Iran, with microsatellite alleles that are not present in the Bulgarian and Turkish genotype. They are therefore not the result of self-pollination. This may suggest that the centre of diversity may be in Iran, but detailed sampling of wild populations has not been carried out in the whole distribution area of the species.(Kole ed. 2011)[cix] (Wild Crop Relatives: Genomic and Breeding Resources Book 2011) pp. 247.

Section 2

Chapter 4

Rosa x damascena

[Fig. 31] *Rosa x damascena* (Image Library, Robert Mattock Roses}

Much of the credibility of this thesis rests on the positive identification of *R. x damascena* [Fig.31] from unlabelled paintings, frescoes, drawings and in descriptions in historical literature. In the absence of the living plant, in-depth experience of cultivating the rose is required to achieve this identification from art and literature. It is a fact (Mattock 2015)[cx] that any rose nurseryman who, as part of his job, has to observe, identify and endlessly, and repetitively, handle the same plant species over days, weeks and months in the course of its cultivation, almost unconsciously becomes acutely aware of that plant's characteristics and idiosyncrasies. That is a very different experience to that of the gardener or a botanist. The professional grower's identification of the Damask is made through a combination of factors that donate a certain "jizz", a set of botanical and horticultural characteristics, [Figs. 27, 28 & 29] that are acquired by knowledge of the type, how the plant grows and the position and location in which it is seen growing. These characteristics are perhaps best summed up in the plant's botanical or scientific description in the table below. There are two forms of this rose, and numerous accessions of both. The once only, summer flowering *Rosa x damascena* var. *semperflorens,* (Mill). the Summer Damask; and the repeat flowering *Rosa x damascena* var. *bifera* (Poir.)

the Autumn Damask; both are genetically and morphologically indistinguishable apart from their respective flowering periods.

Fig.32 *R x damascena bifera* being grown as pruned garden shrub. (Sangerhausen June 2013)

Fig.33 ***R x damascena*** from "Herbarium Blackwellianum",
by Elizabeth Blackwell, translated by Christoph Jacob Trew, 1750, pl. 82

Fig. 34 *R x damascena semperflorens Hips*. Iran (2015)

Taxonomy of *R. x damascena*

[Table 4]. R. x damascena. Table of Accepted Names, Synonyms and Common Names

Accepted Name	Synonym	Common Name
Rosa x damascena Mill.'	*Rosa x damascena* var. *semperflorens*	Summer Damask
Philip Miller. Gardening Dictionary Ed. 8. Rose no.15: 1768. [cxi](Roskov Y. 2016)	*Rosa x damascena* var. *bifera* (Poir.)	Autumn Damask
	Rosa gallica var. *damascena* Voss	Infraspecific taxon
	Rosa gallica f. *trigintipetala*	Damask rose
	Rosa damascena 'Trigintipetala'	Autumn damask rose
	Rosa belgica Mill	Damaszener Rose
	Rosa calendarum M□nchh. ex Borkh.	突厥蔷薇 Turks Rose (Chinese)
	Rosa centifolia var. bifera Poir	دمشقي Damask Rose (Arabic)

	Rosa multiflora Wrede ex Russig	Four Seasons Rose
	Rosa polyanthos Russig	Monthly Rose (damask)
	Rosa bifera (Poir.) Pers.	Perpétuelle semi-double
		Quatre Saisons
		Quatre Saisons Continue
		Quatre Saisons Tous-les-Mois
		Red monthly
		Rosa bifera (Poir.) Persoon
		Rosa damascena bifera
		Rosa damascena perpetua
		Rosa italica Ferrari
		Rosa X damascena 'Bifera'
		Rosa X damascena 'Quatre Saisons'
		Rosa menstrualis
		Rose de Castile
		Rose de Tous les Mois
		Rosier des Quatre Saisons
		Rosier du Calendrier
		Royal Four Seasons
		"The Mission Rose "Year-Round Rose

Botanical Description of *R. x damascena*

[Table 3] Botanical description of *R. x damascena*

Flowers	Semi-double to double
Size	7cms.
Borne	Mostly solitary, in small tight erect clusters of 3 – 10 blooms.
Colour	Deep pink fading to rose pink.
Scent	Very strong, with a sweet damask fragrance
Buds	Long slender receptacles, like narrow funnels, long slender sepals, long buds.
Flowering period	*x Bifera* flowers repeatedly at six week intervals from June to late September
Flowering period	*x* var. *Semperflorens* flowers once for six weeks in June
Growth	Arching, bushy somewhat lanky spreading
Spines	Long downward facing in irregular sizes
Foliage	Dark green foliage. The leaves are pinnate, with five, sometimes seven, leaflets.
Ploidy	Tetraploid
Seed	*Rosa moschata* Herrm. × *Rosa gallica* L.
Pollen	*Rosa fedtschenkoana* Regel

4.1 Parentage and phylogenetics of Rosa x damascena

The work of Iawata *et al* (Iwata 2000) [cxii] for the first time defined the parentage of *Rosa x damascena.* They selected nursery and botanic garden assessions of four of the oldest Damask varieties from nurseries and botanic gardens, and examined the relationship between the Damask varieties and their putative ancestors, at the molecular level. Randomly amplified polymorphic DNA analysis (see p.20) of the Damask varieties proved that they had an identical profile, indicating they were established from a common ancestor. The samples had not been allowed to reproduce sexually, thus their reproduction depended entirely on vegetative propagation. Iwata et *al* identified three Rosa species, *R. moschata*, *R. gallica* and *R. fedtschenkoana*, as parental species of the original hybridisation by sequencing the internal transcribed spacer of ribosomal DNA (see pp. 20). They also found by examining psbA-trnH spacer sequences that all the four oldest Damask varieties had chloroplasts derived only from *R. moschata*. This triparental origin explains the morphological characteristics such as hip shape, leaf colour and the 'Moss' character, a moss-like growth on the sepals of the flowers, of *Rosa x damascena*.

4.2 Historic geographical distribution of *R. x damascena* 3500 BCE to 500 AD

Remontancy had not been seen in Western Europe before its arrival in Classical Rome, which is why this thesis is concerned with how, where and when the remontancy in *Rosa x damascena* evolved. DNA analysis was required to determine the parentage so as to be able to discover the *point of origin* by plotting the geographical distributions of the parents and where they overlapped. Consequently, a botanical knowledge of the parents became a necessity. [Map 1]

[Map 1] showing the extent of rose water production and therefore *R. damascena* 3500 BCE to 500 AD[cxiii] [cxiv]

Anatolia, Turkey, Syria, Iran, Morocco, Algeria, Libya, Aligarh, Ghazipur and Kannauj, India. Persia

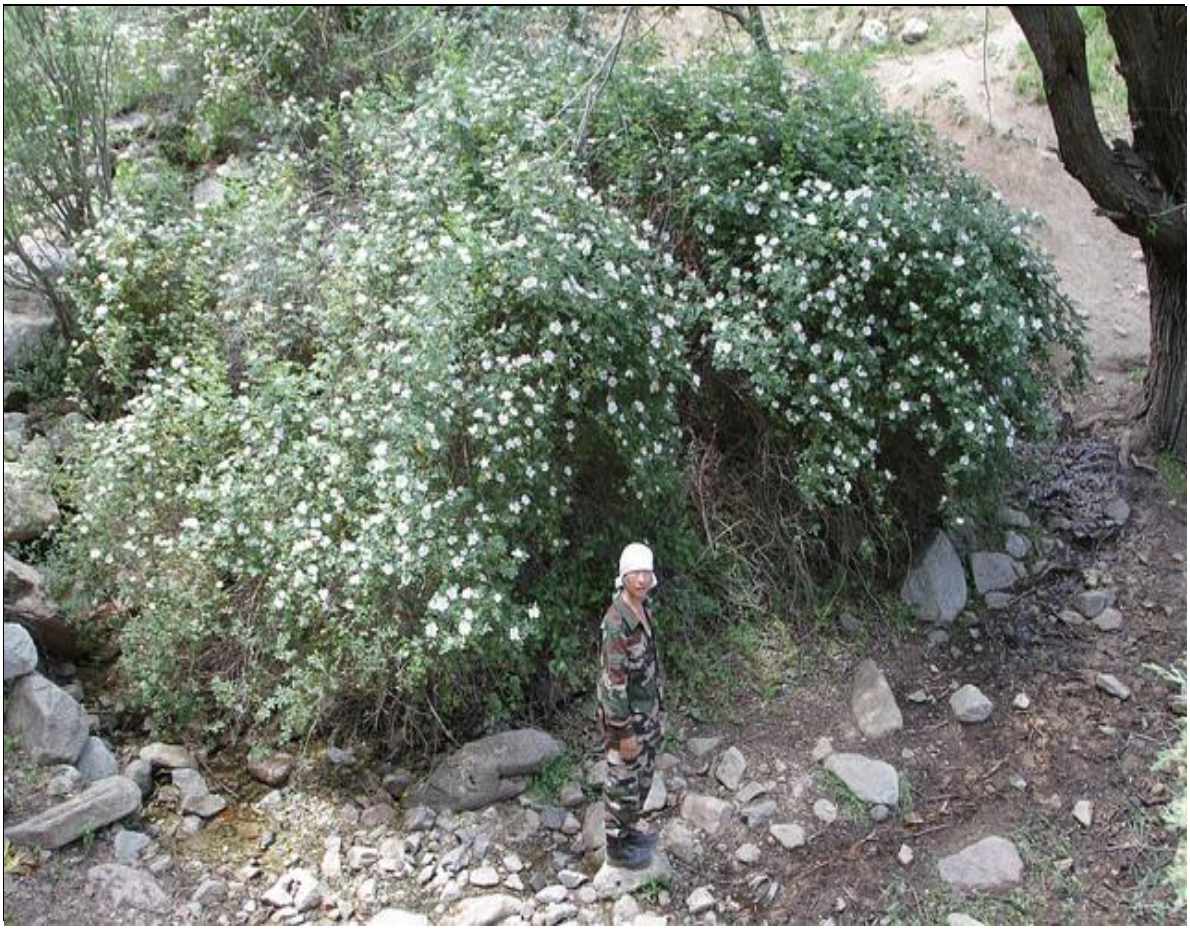
4.3 *Rosa fedtschenkoana*

R. fedtschenkoana, [Fig.35, 36, 37, 38] is one of the few remontant wild roses, and is the remontant, pollen parent of *Rosa x damascena, which* accounts for the remontant nature of the "Autumn Damask" *Rosa x damascena* var. *semperflorens.* [Table 4 & 5]

Fig. 35 Rosa fedtschenkoana,
Oxfordshire 2015.

[Fig.36] *Rosa fedtschenkoana* Hips.
July 2012, Rosenkultivarium Baden, Austria

[Fig.37] *Rosa fedtschenkoana.* Foliage & Spines. Encino, CA May, 2011



[Fig. 38] Magnificent specimen of *R. fedtschenkoana* Taken in: Surkhondaryo, Termiz, Bekzod in Kugitang mountains, Surhanskiy reserve, Uzbekistan. Alexey Yakovlev. The species was discovered in 1871 by Olga Aleksandrovna Fedchenko, a Russian botanist and was named in her honour.

[Table 4] Taxonomic Description *Rosa fedtschenkoana*

Rosa fedtschenkoana Regel	*Rosa caraganifolia* Sumn. Fasali Gulaab
Regel 1878 In: Trudy Imp. S.-Peterburgsk. Bot. Sada 5(2): 314 Tropicos[cxv]	*Rosa coeruleifolia* Sumn. Smummer-ul-ward Summer-e-Gul *Rosa epipsila* Sumnev.
Vols. 1-30(1), 1871-1909; vol. 31(1)-31(2), 1912-13; [1]vol. 32, 1912; vols. 20 (1901), 22 (1904), and 25[1] (1907) constitute: Flora Manshuriae, vol. 1, 2, and [1]3, respectively (author V. L. Komarov) For vols. 30(2), 1913, and 31(3), 1915, see Trudy Imp. Bot. Sada Petra Velikago. http://fig.lib.harvard.edu/fig/?bib=003847275 Superseded by: Trudy Glavn. Bot. Sada[cxvi]	*Rosa lipschitzii* Sumn. *Rosa minusculifolia* Sumn. *Rosa oligosperma* Sumn. *Rosa caraganifolia* Sumn. *Rosa coeruleifolia* Sumn. *Rosa epipsila* Sumnev. *Rosa lavrenkoi* Sumn.

Table 5. Botanical Description *Rosa fedtschenkoana*

Flowers	Single
Size	5 cms.
Borne	Tip-borne mostly singly, but also in twos and threes
Colour	White, pale yellow stamens
Scent	Foetid[cxvii] "like 'Hovis' [brown] bread with a little blackberry jam"(Marriot 2006 [cxviii]
Flowering period	Remontant. Flowers continuously until late autumn
Hips	Bright red pear shaped
Growth	New stems, white. Bushy. Up-right, suckering (1.0m -2.5m)
Spines	New prickles crimson, long slender
Foliage	Grey

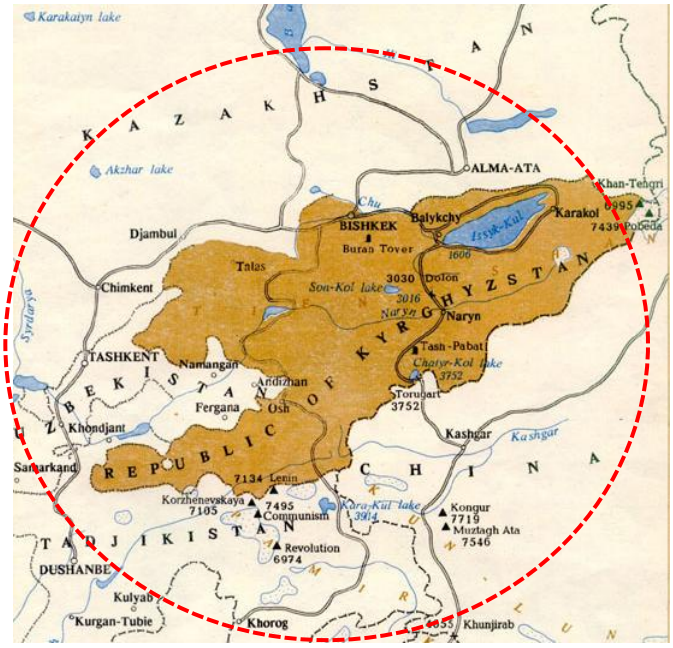
Distribution

The distribution of *R. fedtschenkoana* is not yet fully explored because of its inaccessible mountainous habitat. [Figs. 35, 36, 37] Nevertheless evidence, from the *Floras* and the *Medicinal Plants of Central Asia* (Eisenman 2013) [cxix] are shown in the following table [Table 5] Crucial to ascertaining the point of origin of *R. x damascena* is that its pollen parent grows as an indigenous plant in the Uzbekistan provinces of Toshkent, Far'gona, Samarquand, Qashqadaryo, Surxondaryo. This is where it overlaps with the distribution of *Rosa gallica* and *Rosa moschata* Herrm. [Maps 2, 3, & 4]

Table 6. Geographical Distribution of *Rosa fedtschenkoana*

Location	Reference
Ala Tau Mountains, foothills.	Philips & Rix 2004 [cxx]
Tian Shan, foothills.	Philips & Rix 2004 [cxxi]
Pamir-Alai, foothills.	Philips & Rix 2004 [cxxii]
Kazakhstan	Roskov Y. *Catalogue of Life:* 2016 [xlv] Trudy *Flora of China* 2016[cxxiii]
North West China	Philips & Rix 2004 [cxxiv]
Kyrgyzstan. All provinces	Eisenman et al 2012[cxxv]
Uzbekistan provinces	Eisenman et al 2012
Toshkent	Eisenman et al 2012
Far'gona	Eisenman et al 2012
Samarquand	Eisenman et al 2012
Qashqadaryo	Eisenman et al 2012
Surxondaryo	Eisenman et al 2012
Tajikistan, Zaravshan Mountains	Magdelana 2016[cxxvi]

[Map.2] The provinces of Uzbekistan http://www.nationsonline.org/oneworld/map/uzbekistan-administrative-map.htm
The provincial distributions of *R. fedtschenkoana* are marked in red.



[Map. 3] Tien Shan Physical Map Posted by Allan L. Murdock
Superimposed with the distribution of *R. fedtschenkoana*

[Fig.39] *R. fedtschenkoana* habitat. Mid-mountain xerophytic light forest ecosystems. Tien Shan, alplager Ala Arča in Kirgizian Ala Tau (www.gore-judje.net)

[Map. 4.] The geographic al distribution of *R. fedtschenkoana*

Habitat

[Fig. 40] *R. fedtschenkoana* habitat. Early spring in the foothills of the Kuznetsk Alatau. Copyright: Evgeny Gerasienko

[Fig. 41] *R. fedtschenkoana* habitat Tajikistan.

Despite that the DNA analysis by Iwata *et al* shows that several authorities still cite *Rosa phoenicia* and *Rosa abyssinica* as parents of *Rosa damascena*. The arguments for and the sources are discussed in Case Study 2 [42] and in the Syrian Rose project [p.150].

4.4 *Rosa gallica*

Rosa gallica [Fig.38] is a rose species indigenous to central and southern Europe, including [Fig.42, 43] France (hence gallica), through to Ukraine, Turkey and Iraq,' Northern Iran, Turkmenistan and Uzbekistan. [Map 5.]. Natural variation has given rise to single forms, and those with a few extra petals, of which the best known is *R. gallica* 'Officinalis' The suffix, 'Officinalis', indicates its use by pharmacists, hence another common name 'The Apothecary's Rose'. *Rosa gallica* forms a deciduous shrub forming large patches of shrubbery. The stems are covered with prickles and glandular bristles. The leaves are pinnate, with three to seven bluish-green leaflets. The flowers are clustered one to four together, single with five petals, fragrant, deep pink. The hips [Figs. 44, 45, 47, 47] are globose to ovoid, 10-13 mm diameter, orange to brownish.

Both *Rosa gallica* and *Rosa x damascena* are polymorphic, exhibiting forms of flower that can be very similar from single to very double. The distinguishing feature in the wild is the habit of the growth. *R. gallica* presents as an almost dwarf shrub whereas *R. damascena* is a large, lax straggly bush.

[Fig.43] *Rosa gallica* growing in the wild. Photo Id: 247392 Help me Find

[Fig.44] *Rosa gallica* Hips.

[Fig. 45] *Rosa gallica* Hips France 2013

Table 7 *Rosa gallica* Taxonomic Description

Accepted Name	Synonym	Common Name
Rosa gallica	*Rosa arvina* Krock.	Essig-Rose
	Rosa assimilis Déségl.	Französische Rose
	Rosa atropurpurea Boullu	French Rose
	Rosa austriaca Cr.	Provins Rose
	Rosa belgica Brot.	The Apothecary's Rose
	Rosa chrshanovskii Dubovik	Rosa gallica 'Versicolor'
	Rosa cordata Cariot	Rosa Mundi
	Rosa cordifolia Host	R. gallica 'Officinalis'
	Rosa crenatula Chrshan.	Rosier d'Autriche
	Rosa czackiana Besser	
	Rosa gallica subsp. *austriaca* (Crantz) Nyman	
	Rosa gallica var. *eriostyla* Keller	

	Rosa gallica subsp. *leiostyla* (Gelmi) Soó	
	Rosa gallica subsp. *pumila* (Poir.) Nyman	
	Rosa grandiflora Salisb.	
	Rosa grossheimii Chrshan.	
	Rosa hispida Muench.	
	Rosa holosericea Du Roi	
	Rosa homoacantha Dubovik	
	Rosa humilis Besser	
	Rosa krynkensis V.M. Ostapko	
	Rosa livescens Bess.	
	Rosa mirogojana Braun & Vukot.	
	Rosa oligacantha borb. (synonym)	
	Rosa olympica Donn	
	Rosa parviuscula Chrshan. & Laseb.	
	Rosa pinnatifida Andrews	
	Rosa pumila Jacq.	
	Rosa pumila Scop.	
	Rosa pumila var. *holosericea* P.V. Heath	
	Rosa pygmaea Bieb.	
	Rosa racemosa Andrews	
	Rosa ratomsciana Bess.	
	Rosa repens Muench	
	Rosa rhodani Chab. ex Boullu	
	Rosa rubra Lam.	
	Rosa ruralis Déségl.	
	Rosa schistosa Dubovik	
	Rosa subpygmaea Chrshan.	
	Rosa sylvatica Gater.	
	Rosa talijevii Dubovik	
	Rosa tauriae Chrshan.	
	Rosa ucrainica Chrshan.	
	Rosa umbrosa H. Waldner	
	Rosa velutinae flora Déségl.	
	Rosa virescens Déségl.	

[Table 8]. *Rosa gallica.* Botanical description.

Flowers	Single
Size	6 cms.
Borne	Singles primarily, but sometimes up to five on short stout stems.
Colour	Bright pink fading to pale pink. White eye. Golden stamens
Scent	Strong. Light lemon

Buds	Sepals and receptacles exude a sticky resin scent
Flowering period	Once flowering
Hips	Round, dull vermillion
Growth	Short, thicketing (0.50 – 1.20m) wiry upright habit. Suckers on its own roots. Can climb.
Spines	Few, sharp, slim, triangular
Foliage	Mid green

Habitat

[Fig 46.] *Rosa gallica* in S. W. France. Note how it suckers in a similar fashion to *Rosa damascena*
Source: http://www.naturemp.org/Rosier-de-France.html

[Fig. 47.] *Rosa gallica*, Hips. Portugal
L. Lopes 2006

Pharmacological Use

R. gallica has been used for cosmetic and medicinal purposes, and are still are taken internally in the treatment of colds, bronchial infections, gastritis, diarrhea, depression and lethargy. Externally, they are used to treat eye infections, sore throats, minor injuries and skin problems.

Culinary Use

The petals may be eaten raw or cooked, they can be added as a decorative garnish to salads, and can be crystallised or preserved in syrup. They are also dried and used as a flavouring in tea, beverages and cakes The dried petals and flower buds are an important ingredient in the Northern African spice mixture *"ras-el-hanout".*

Geographical distribution of *Rosa gallica*

[Map 5]. Showing the geographical distribution of *Rosa gallica* that includes, Central Europe, Poland (Geobotanica Polonica)[cxxvii], France, Spain, Italy, southern Europe, through to Ukraine, Caucuses, Turkey, Aechemid Persian Empire/Turkmenistan, Northern Iraq, Iran / Persia[cxxviii cxxix] Abkhazia, Azerbaijan, Georgia, S. Russia [cxxx] Iran, Afghanistan, Turkmenistan and Tajikistan [cxxxi]

4.5 *Rosa x moschata* Herrm.

[Fig.48] *Rosa moschata* Herrm.

The research project, The Evolutionary Genetics and Taxonomy of *Rosa x moschata*, (Case Study 2. P.33) aspires to lay to rest the identification of what is and what is not *Rosa moschata.* [Fig.48] The subject of much taxonomic conjecture, because this Musk rose has been cultivated as a garden plant alongside, or within, its distribution in the wild. Furthermore, there appears to be variation in the form and colour of the flowers across its range. The *Floras* are currently the only definitive source of where it is found in the wild and the distribution map below is based on those sources. It appears to be a naturally occurring hybrid that was selected for its relative lack of thorns, excellent scent and late flowering, as well as its medicinal value as a purgative. Ivan Louette, the Belgian rosarian, has made a detailed study of this plant, and related forms in Iran. (Louette 1999)[cxxxii]

Graham S. Thomas refers to the description of *Rosa moschata* published by Johannes Herrmann in his Dissertation de Rosa 1762 (Hermann 1762) [cxxxiii] This is a large shrub with dull green foliage, which until the first frosts produce white flower panicles of medium, single double flowers with a pronounced fragrance of musk. [Fig.44]. Hermann goes on to say that it was spread by the Arabs throughout the Mediterranean basin. In 1820, John Lindley noted the similarity between *R. moschata* and *R. brunonii,* a wild rose of India later called the *Himalayan musk rose*. The problem is that the name *R. moschata* has also been applied to *R. ruscinonensis*, from southern France; R. *abyssinica* from East Africa and Saudi Arabia; R. *brunonii* from the Himalaya, and R. *sambucina* from China and Japan. Nevertheless, the use of the relevant *Floras* and taxonomy has given confidence that the distribution of the correct plant has been deduced, therefore the *Rosa moschata* referred to in this thesis, and that referred to by Iawata et al in their work published in 2000

'Triparental origin of Damask roses' (Iawata 2000)[cxxxiv] , is the *Rosa moschata* Herrm. as defined in the Plant List. [Figs. 44, 45, 46, 47 & 48]

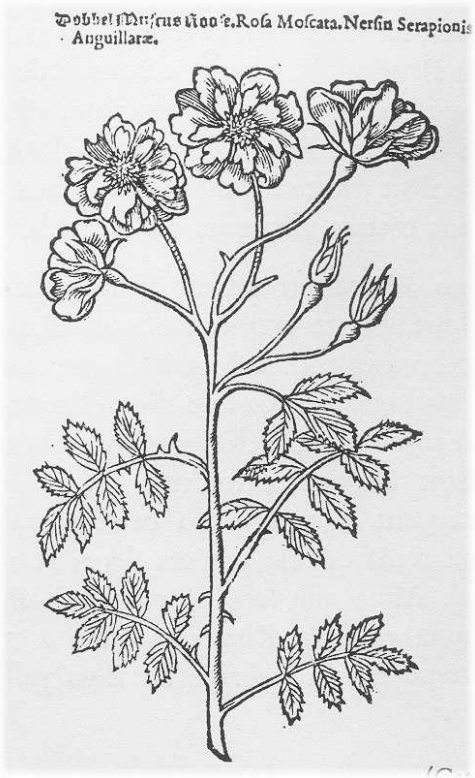


Fig. 49 *Rosa moschata.* © Ivan Louette et Commune de Chaumont-Gistoux.
Reproduction électronique autorisée moyennant mention de la source. http://www.botarosa.org/botarosa/roses/grappes/moschill.htm#serapion

Fig. 50 *Rosa moschata*; botanische-spaziergaenge.at Thema anzeigen - 24. Woche

Fig.51 *Rosa moschata* Herrm. Hips. http://plainfieldgardenclub.org/ =1757

Fig.52 Rosa *moschata* Herrm. Western Himalayan shrub form. http://www.ludwigsroses.co.za/

[Table 9.] *Rosa moschata* Taxonomic Description

Accepted Name	Synonym	Common Name
Rosa moschata J. Herrmann	*Rosa arboreal* Pers.	Musk Rose
	Rosa broteroi Tratt.	Moschus rose
	Rosa brownii Tratt.	Gol-e moškin
	Rosa manueli Losa	"Graham Thomas's Musk"
	Rosa nepalensis Andrews	Rosier Musqué
	Rosa opsostemma Ehrh.	Single Musk
	Rosa pissardi Carr.	
	Rosa recurva Roxb.	
	Rosa ruscinonensis Gren. & Desegl.ex Desegi.	
	Rosa sempervirens Dup.ex Steud.	
	Rosa moschata 'Plena'	

[Table 10] *Rosa moschata* Botanical description

Flowers	Creamy white
Size	5 cms
Borne	Loose clusters on slender 3cms. stalks
Colour	Creamy white. Wavy, pale yellow, stamens.
Scent	Strong, musky
Buds	Pointed
Flowering period	Blooms in flushes throughout the season. September, October
Hips	Small oval, with protruding
Growth	Low dimber (5.0m)
Spines	Very few, straight thorns.
Foliage	Light green. Five to seven leaflets, ovate (2cm) long.

Geographic Distribution of Rosa moschata Herm.

The following map illustrates the geographical distribution of *Rosa moschata* Herrm.

Sources. N-India, Nepal, (World Plants, Oct 2016) Corfu, N. India, Afghanistan, Iran, Pakistan (Louette 2002, Iraq, Iran, Afghanistan to Kashmir. Mediterranean. Iraq, Iran, Afghanistan, N India and Java. Persia[CXXXV] (Backer & Van Brink 1, 1963; Hegi IV (2), 1923; Ochse & Van den Brink 1931, 1005 pp.; Terra 1966, 107 pp.; Vul'f & Maleeva 1969, 566 pp.)

[Map. 6] Geographical distribution of *Rosa moschata* Herrm

4.6 *Rosa phoenicia* and *Rosa abyssinica*

Despite that using DNA sequencing Iawata et al showed beyond all reasonable doubt that are the parents of *Rosa x damascena* there remain authorities who still insist that the parentage includes *Rosa phoenicia* and/or *Rosa abyssinica.* The issue is discussed in Case Study 2 (p.42) and in The Syrian Rose project (p.146).
For the sake of completeness the following descriptions have been included.

4.7 Rosa abyssinica R.Br. nom.nud.

R. abyssinica [Figs. 71 & 72] has recently been suggested by Ivan Louette of Belgium, to be part of the Rosa moschata complex. *R. abyssinica also* known as *Rosa × richardii,* or holy pink, or pink Abyssinian Rose St. Jean, is low growing shrub with white single flowers grouped in corymbs in panicles. It has been know known since antiquity and is a spontaneous hybrid between *Rosa gallica* × *Rosa Phoenicia.*

Images are Copyright Brian J. McMorrow
[Fig. 53] *Abyssinian Rose (Rosa abyssinica) Simien Mountains 21.01*

[Fig. 54] Hips, *Rosa abyssinica* ispb.univ-lyon1.fr

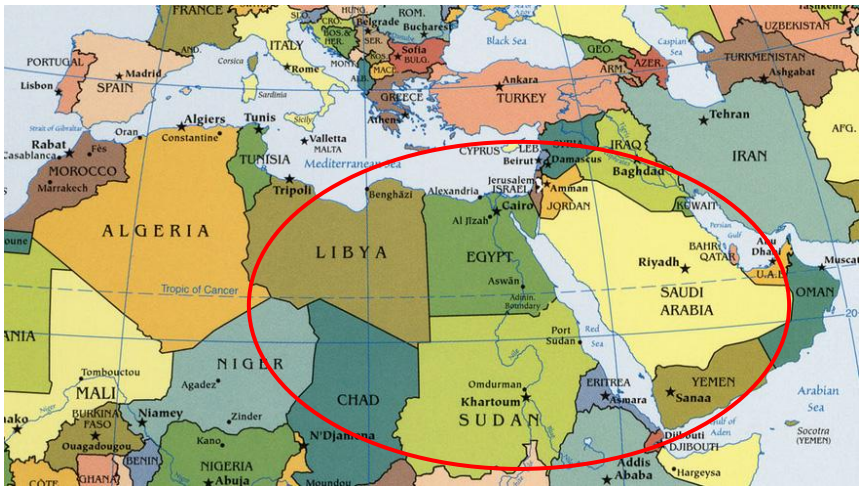
[Fig. 55] *Abyssinian Rose (Rosa abyssinica*) Simien

[Table 11]. *Rosa abyssinica* Taxonomic Description

Provisionally Accepted Name	Infraspecific taxon:	Common Name
Rosa abyssinica R.Br., nom. nud	*R. moschata* var *abyssinica*	Arabia's wild rose
Rosa abyssinica R.Br. ex Lindl.		Holy Rose
		Pink Abyssinian Rose

[Table 12]. *Rosa abyssinica* Botanical Description

Flowers	Single, solitary or groups of 2/3
Size	3 - 4 cms
Borne	Small, in large clusters bloom form.
Colour	White
Scent	Strong rose plus cloves
Buds	Long pointed sepals
Flowering period	Long flowering period
Hips	Reddish black, smooth, egg shaped (1.5cms)
Growth	Straggly shrub, scrambler
Spines	Short, recurved
Foliage	Bright green, ovate to oblong, fine shallow teeth



[Map. 7] Distribution of Rosa abyssinica.

Rosa abyssinica. The only rose growing wild in sub Saharan Africa, in Ethiopia, and across the Red Sea [Fig. 100] in Saudi Arabia. (Philips & Rix 2003)[cxxxvi] [Map 10] G.S. Thomas stated that "the rose originated in Syria in the 4th century, where, in 1954, it was by then unknown". Can be found in Yemen, Ethiopia, and Somalia. (Thomas 1979)[cxxxvii]

4.8 *Rosa phoenicia* [xxiv]

Often cited as a parent of *R. x damascena* including (Mahboubi 2016) *R. phoenicia* [Figs. 105, 106] is included here for that reason. Indigenous to the Middle East. The branches, resemble vine shoots. It is resilient to dry soil and hot climatic conditions.

This rose is considered by the Anatolians as one of the possible parents of the Damask.

[Fig 13] *Rosa phoenicia*

Fig. 57. Rosa *phoenicia* Vintage 1957 Botanical Print with Bible Verse Book Page

[Map. 8] ***Rosa phoenicia*** **Distribution** Turkey, Syria, Lebanon. Lebanon , Syria , Israel , Turkey

[Table 13]. *Rosa phoenicia* Taxonomic Description

Provisionally Accepted Name	Infraspecific taxon:	Common Name
Rosa phoenicantha Gand.	*Rosa phoenicia* Boissier	
	Rosa phenicia Bu. , 1849	

[Table 14]. *Rosa phoenicia* Botanic Description

Flowers	Single
Size	2.5 cms
Borne	Small, in large clusters bloom form.
Colour	White to blush
Scent	Musk
Buds	Leafy sepals and buds.
Flowering period	Once only
Hips	Ellipsoids fruit, orange, 10 to 15 mm long.
Growth	Vine like Height of 8' (245 cm). Width of 4' (120 cm).
Spines	
Foliage	Medium green wrinkled (rugose) foliage. 3 to 5 leaflets.
Ploidy	Diploid

4.9 The geographical and botanical point of origin of Rosa x damascena.

This thesis proposes that cultural linkage facilitated the transmigration of the remontant gene in the Damask rose, from the river Amu Darya watershed in Uzbekistan, the river Oxus valley of Classical Latin and Greek, circa 3,500 BCE., to arrive in Classical Rome by 300 BCE., and how the rose extended its range throughout the Middle East and Mediterranean by 1400 CE. The geographical point of origin of this naturally occurring hybrid had remained unclear up until this research, save for an educated guess that it might have come from Northern Persia. The research, explained in the preceding chapters, has now permitted the construction of two sets of data.

Firstly, detailed in Chapter 4, is the research into the various *Floras* of Central Asia, for the geographical distribution of *Rosa x damascena* and its parents, *Rosa gallica, Rosa moschata* and *Rosa fedtschenkoana*. The term '*Flora*' refers to the plants occurring within a given region, as well as to the publication of scientific descriptions of those plants. A *Flora* may contain just a simple list of the plants occurring in an area, to a very detailed account of those plants. *Floras* contain scientific names, and may also include common names, literature references, descriptions, habitats, geographical distribution, illustrations, flowering times, and

notes. The distributions of *Rosa x damascena*'s parents, *Rosa gallica, Rosa moschata* and *Rosa fedtschenkoana*, have been updated over the last ten years, pertinently, the distributions of *Rosa gallica* and *Rosa fedtschenkoana*. Recorded distributions of the latter in the Floras and the *Medicinal Plants of Central Asia* (Eisenman 2013) [cxxxviii] have effectively extended the geographical distribution of *Rosa fedtschenkoana,* and research into the historical records of roses of the Persian Empire have extended the range of *Rosa gallica to* the extent that a significant overlap of some 180,000 square miles (450,000 square kilometres) has been plotted between all three parents. This information has only recently become available hence previous authors on the subject have deemed the overlap of the three parents, improbable or impossible. Only by reading the reports of the plant collectors who provided the material for each country's, or region's *Flora,* has it proven possible to plot the approximate natural distribution of each of the three parents of the hybrid Damask Rose. Whilst the point of origin of the hybrid is located within a region where the distributions of the hybrid's parents overlap, clearly, this is an inexact science and as such open to discussion because there are so many variables. Issues over the recording of the exact location, or the correct identification; synonyms for the same plant, or for different plants, are the most significant vagaries. However, this thesis has not sought to accurately pinpoint the very centre of the range of the distribution of *Rosa x damascena.* It is has sought instead, to identify the region of its origin within a degree of tolerance sufficient for this thesis to evidence a sufficient degree of overlap to take in to account the very limited vagrancies of insect pollination.

It has been suggested that rose hips might have been carried in horse droppings, much in the same way that Barrie Juniper and David Mabberley have hypothesised that *Malus sieversii* transmigrated from the slopes of the Tien Shan mountains in Kazakhstan. (Juniper & Mabberly. 2006. The Story of the Apple.)[cxxxix] Horses do not eat rose hips because the fruits are bitter.

Since rose seed is too heavy to be carried in the plumage of the few *passerines,* the thrushes, that eat rose hips, and *Rosa x damascena* bears hips which are stripped bare by local birds before migration of passerines starts in the region, (Cramp 1988)[cxl] it is unlikely that birds were the sole contributors, if they were at all, to bringing one parent into contact with another. Consequently, so long as the distributions plotted, overlap by several times the distance a pollinating insect is able to travel from the pollen plant, the overlap that occurs is the most likely region of origin [Map 17].

The insects that pollinate roses only travel within a limited range, normally no more than ten kilometers from the pollen plant. Consequently, to determine the point of origin of *Rosa x damascena* this thesis had to evidence an overlap of at least ten kilometres, because a ten kilometre margin is insufficient to allow for the margin of error required to cope with the inexactitudes of botanical distribution plots. On that basis, plotted below are geographical distributions, described in detail above, of the three parents of *R. x damascena*, *R. gallica*, *R. moschata*, and *R. fedtschenkoana.* The overlap in the three distributions, plotted below [Map 7.] is the most likely point of the origin of *R. x damascena.*

[Map.9]. The geographical distribution of the parents of *R. x damascena* and their overlap indicating the point of origin of R. *x damascena*

Rosa moschata
Rosa gallica
Rosa fedtschenkoana

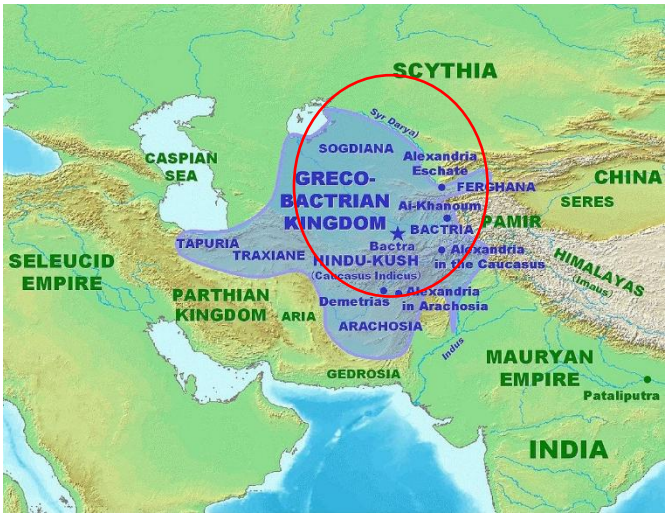
The overlap in the parental distributions indicates that the likely point of origin of *R. x damascena* is in a range extending over the watershed of the river Amu Darya that includes the foothills of the Tien Shan.

NB.

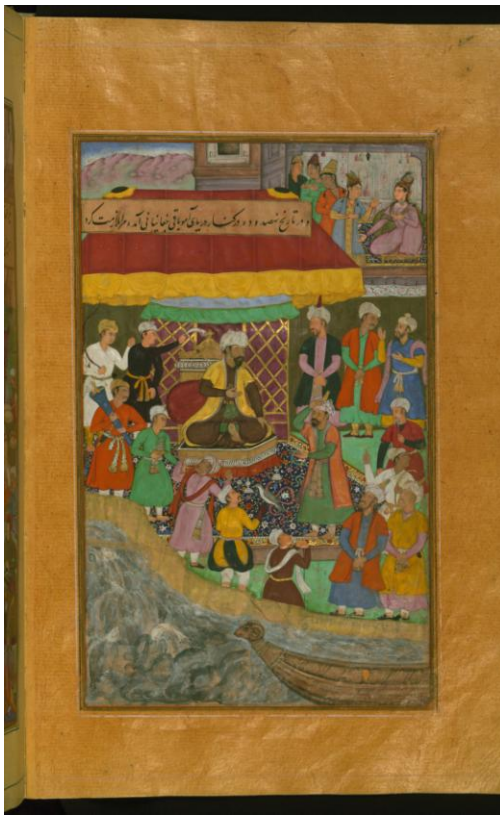
The ellipses have been drawn to illustrate the overlapping distributions of the parents of *R. x damascena* by plotting only the maximum extent geographically of their occurrences as reported by plant collectors and records from the Floras. Plotting each occurrence of the plants concerned would not add clarification to this thesis because the over lapping distributions would appear confused and are therefore considered to be the subject of a further work.

Panning into the map where it shows the three overlapping distributions reveals the point of origin to lie within the watershed of the great Amu-Darya river. The river is the Transoxiana of Alexander the Great, the River Oxus of classical Latin and Greek, and the "foiled circuitous wanderer" in Matthew Arnold's (1822-88), *Sohrab and Rustum* (Arnold 1853)[cxli]. Some 1,385,000 square kilometres (535,000 square miles) of land is drained by the Amu Darya into the Aral Sea basin, a closed endorheic drainage basin, which retains water but allows no outflow, but converges instead into a series of lakes or swamps, now for the most part drained. The watershed includes most of Tajikistan, the southwest corner of Kyrgyzstan, the northeast corner of Afghanistan, a long narrow portion of eastern Turkmenistan and about half of Uzbekistan. About 61% of the drainage lies within Tajikistan, Uzbekistan and Turkmenistan, while 39% is in Afghanistan. (Rakhmatullaev et al 2009).[cxlii] The high volume of water flowing through the Amu Daryä comes almost entirely from glaciers in the Pamir Mountains and Tian Shan, which, standing above the surrounding arid plains, collect the available atmospheric moisture. The river is the only source of fertility in this harsh, arid, dry region. Without its mountain water sources, the Amu Darya drainage system would not exist because it rarely rains in the lowland areas through which most of the river flows, and where the annual rainfall is less than 300 millimetres per annum.

[Map 10]. The river Amu-Darya watershed



[Map 11]. The river Amu Darya (Oxus) watershed was the nucleus of successions of Bactrian civilizations. 329 – 125 BCE and the interface between Central Asia and the Chinese Han Dynasty.



[Fig. 58. Bāqī Chaghānyānī pays homage to Babur beside the Amu Darya River, 1504 CE

It is important to know when scanning Literary Sources, that in classical antiquity, the river was known as the *Ōxus* in Latin and Ὦξος *Ôxos* in Greek. In Vedic Sanskrit, the river is also referred to as Vakṣu. In Middle Persian sources of the Sassanid period, the river is known as *Wehrōd* the "good river". (Spuler 2009)[cxliii] . Medieval Arabic and Muslim sources call the river *Jayhoun* (جیحون) which is derived from *Gihon*, the biblical name for one of the four rivers of the Garden of Eden. The Oxus was the nucleus of several successions of Bactrian civilizations and kingdoms [Fig.53] and was the borderline between the Persian satrapy of Sogdiana northward, and Bactria southward; the western part belonged to nomads. Confirmation that Rose water was in use in the region by 1405, come from records that state that Tamerlane (1336-1405) the Turco-Mongol conqueror, died in February of that year on his way to China. His body was perfumed with rose-water, musk and camphor, placed in a coffin decorated with pearls and then dispatched in the dead of night, to avoid unsettling his troops back, to Samarkand 400 miles away. (Silkadventure 2016)[cxliv].

Caveat, Validity and Precision.

It is proposed in this thesis that the overlapping parental distributions of *R x damascena* indicate that the *point of origin* of the rose was the watershed of the great Amu-Darya river. This *point of origin* is caveated with the fact that the botanical distributions that create the overlap illustrated in [Map 9] are dependent on the accuracy of published locations reported by plant collectors and botanists in the field. It is acknowledged, that simply connecting the dots between these reported finds, renders the outline of distribution approximate rather than precise. Plotting botanical geographical plant distributions is, by definition, an inexact science, however plots are perfectly acceptable for the purpose of this thesis

4.10 The Cultivation of *Rosa x damascena*

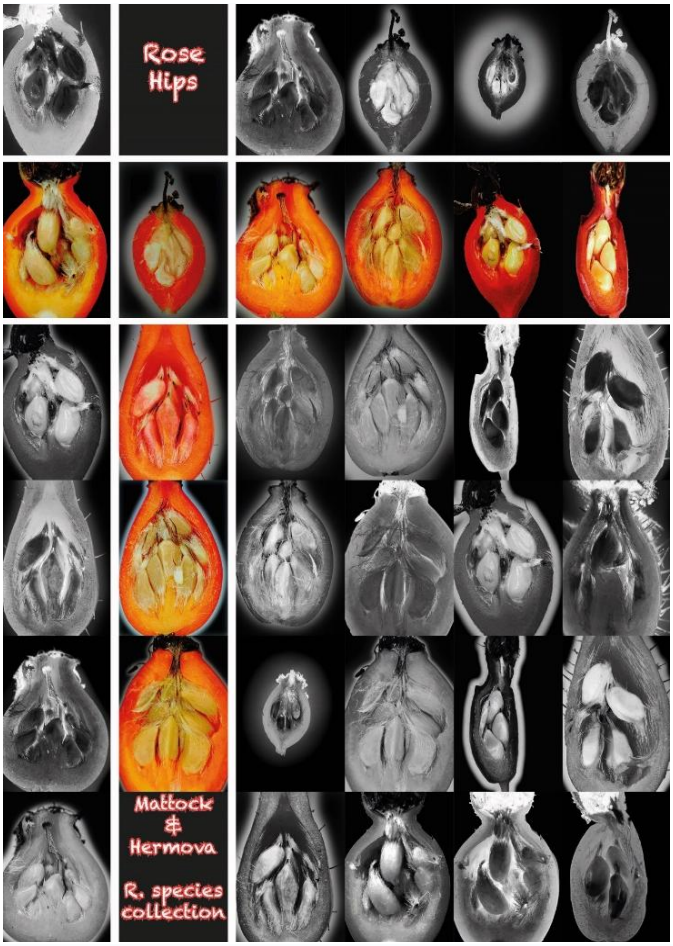
Comparative studies of methods used to propagate and cultivate *Rosa x damascena.*

A comparative study of the known commercial methods used to propagate and cultivate roses, to establish how it was historically possible to propagate, and to cultivate, *Rosa x damascena* under the harsh climatic constraints of Central Asia and the Middle East.

Propagation

Seed.

Propagation by seed within the area of geographic distribution of the Damask is possible, but onerous. This is because climatically, the seed requires periods of prolonged, near freezing, temperatures for four months, and then two further years to germinate. Commercially, growers do not have that length of time to devote to the process. One possible way to reduce this time is to scarify the seed, and then place it for two or three weeks in a damp medium at a temperature of 27° - 32°C. followed by four months at 3°C.
Scarification involves weakening, opening, or otherwise altering the coat of a seed, mechanically, [Fig. 54] thermally, and chemically to encourage germination. It is also possible to sow seed immediately it is harvested when "green"; that is, when the seed is fully developed, but before it has dried on the plant.

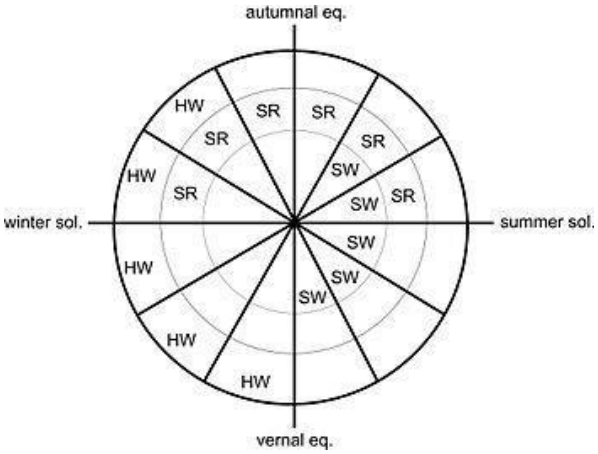


[Fig. 59] Photograph of rose hips from the poster which will advertise the field identification guide. Hermova 2016. (Case study 4.)

Vegetative Propagation

Leaving aside recently developed laboratory methods of propagation such as micro-propagation, there are only a certain number of methods that can be used for vegetatively propagating roses. Only those methods detailed below [Figs. 56-62], have been used traditionally, methods that have not changed over the last four thousand years. Had those methods included cuttings of any description, the timing for making the cuttings had to fall within the seasonal constraints in the table below [Fig 55].

[Fig.60]. [Fig. 26] Chart showing the months for making cuttings in the northern hemisphere

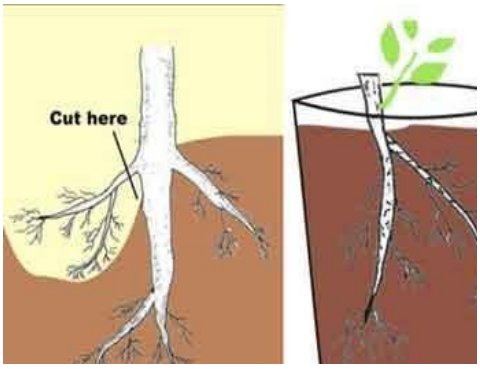


Key

HW = hardwood cuttings

SR = semi ripe-wood cuttings

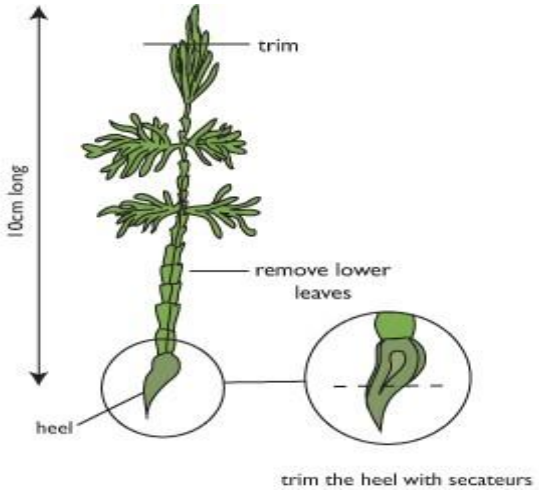
SW = softwood cuttings



[Fig.61 **Root Cuttings**;
Very susceptible to desiccation

Stem Cuttings

[Fig.62] Softwood Cuttings Material lasts for just a few hours



[Fig. 63]. Semi Hardwood Cuttings.

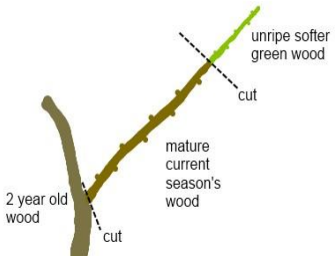
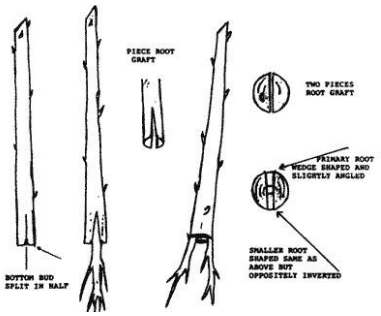
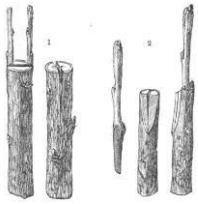


Fig. 64 Hardwood Cuttings

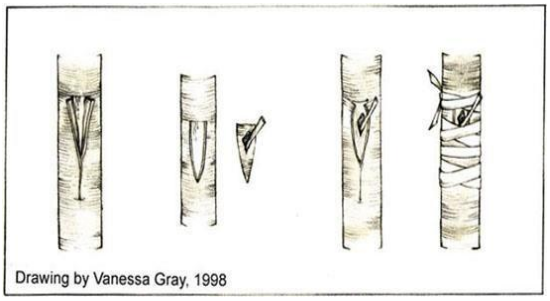
Grafting This propagating material can last for up to seven days if kept moist and cool.



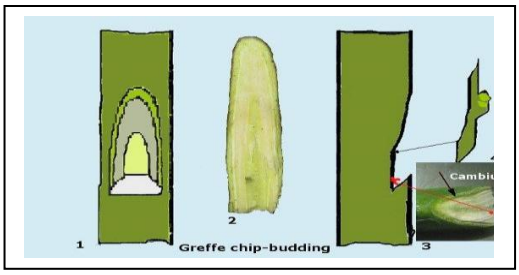
[Fig.65] Root grafting



[Fig.66] Crown grafting/ Whip or tongue graft



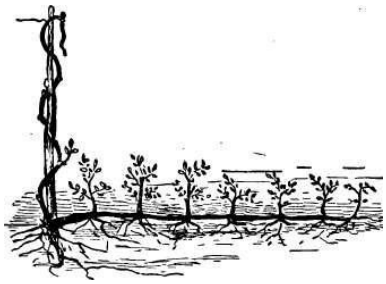
[Fig.67]. T - Budding. A form of grafting technique favoured by commercial rose growers for the last three thousand years, throughout Asia, Europe and North Africa.



[Fig.68] Chip budding

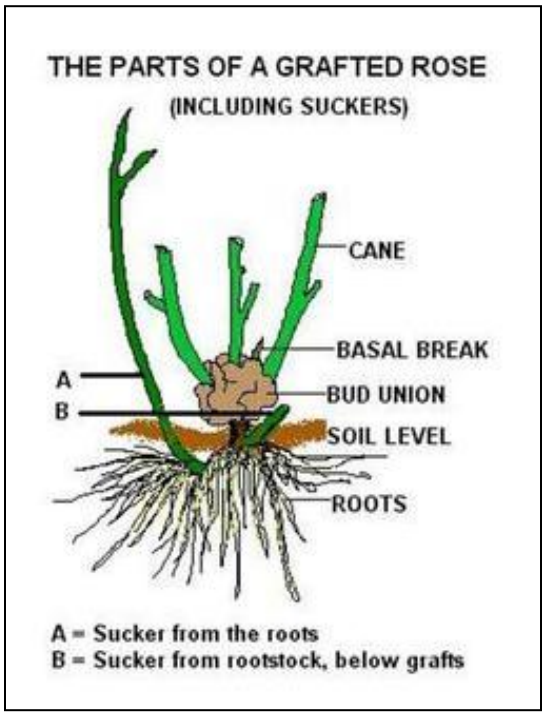
Fig. 69 Layering or suckering.

The technique used traditionally throughout Central Asia for propagating and cultivating the Damask.



[Fig.70] Trench layering

[Fig.71] Suckers



[Fig.72] Suckers

Planting suckers ripped off from the root of the mother plant is the traditional method of propagating *Rosa x damascena*, and has been practised for 3000 years in Central Asia and was seen in Morocco, in 2015. The method, that involves 'ripping' a piece of mature stem, that is still attached to a piece of mature root, is not subject to desiccation to the extent of the propagating material used for cuttings and grafts.

4.11 Historic transportation of propagating material

Is it possible to transport propagating material over long distances, in harsh climatic conditions?
Whilst the research has established that Islamic aggressors could have insisted that their converts use rose water as part of their Muslim doctrinal rites, was it physically possible to establish the production of rose water from *R. x damascena,* under the harsh terrain and climatic conditions of the settlements that had been subjected to Islamic conversion? An expedition was mounted to ascertain whether it is possible to propagate and establish *R. x damascena* south of the Atlas Mountains in sub Saharan Morocco, a region that is representative of the topographical regions of Muslim conversion. This was followed by a comparative study of the methods used in Morocco, and those traditional methods used in Iran.
All rose growing professionals are well aware of the fragility of transporting propagating material. The fragility is primarily a function of desiccation, and the smaller the piece of propagating material the higher the risk of it drying out and the less time the propagator has to make the new plant from whatever piece of the mother plant he decides to use. Consequently, transporting small pieces of propagating material for any length of time more than a few minutes is not viable. Therefore, cuttings have to be made and struck in situ which is possible if there is stock close by to the planting plot but not if the propagating material has to travel any distance. Conversely, hard wood torn from mother stock in the form of suckers or layers, will last several days even weeks if kept moist and well-covered in moist blankets or moist hessian sacking.
[Page 91, below]

4.12 Literary review of the Classics to establish which methods were used to propagate and cultivate *R x damascena* in antiquity.

The issue arises, why have a succession of translations from the Classics ignored the horticultural term "sucker" when applied to propagating roses. To a professional grower mono-specific vegetative propagation by *suckers* corresponds to commercial volume production because it is the one inexpensive, technically simple, means of producing thousands of plants of the same species or species-hybrid. Important to this thesis, is how the Damask rose was able to be transported from the River Oxus (Amu Dyra) watershed in about 3500 BCE to Rome by 300 BCE. This is significant, because in the harsh arid and hot climates of Central Asia and the Middle East, propagating material such as *cuttings, grafts, whips, layers, saplings* and *quicksets* would not have survived due to desiccation. The only form of propagation material that survives these

climatic extremes are *suckers*. Propagation of rose species by suckers is a ubiquitously used technique whereby stems are ripped off the root ball of a species rose retaining a portion of both the tap root and adventitious roots. A bundle of suckers, normally ten to a bundle, wrapped in a blanket or in hessian squares, and kept moist and in the shade, can remain viable for several months thereby allowing them to be successfully transported from one arid area to another.
Robin Lane Fox when asked for his opinion stated that Pliny wrote that suckers have been used to propagate vines since antiquity (Pliny [1])).

"De cetevo ipsa se colit stolones supervacuos enecante
Idem saepe praebet in singulis *vitulamen*".
"For the rest the tree looks after itself, as its shadow kills off superfluous *suckers*".

In the same passage, Pliny refers to suckers as *stock-shoots* which they translate as *propagines*.
Why, if the term sucker is used in the description of the cultivation of vines, is not it used to describe what was a widespread method of propagation of roses? Instead the words *viviradices, flagellis* and *mergis* have been used in translations, by for example Bostock, and Fée, of those agriculturally and horticulturally knowledgeable writers, such as Pliny, Virgil, Theophrastus, Dioscorides and Columella. These words do not seem to describe a '*sucker*', albeit that the writers describe the production of rose water, and it follows, the cultivation of the Damask, in considerable detail.
Quotations, from Columella's: *De Re Rustica and De Arboribus* illustrates the point on [Page 90]. The references and quotations are from the Loeb Classical Library edition: Vol. I (Books 1-4) by H. B. Ash, published in 1941; Vols. 2 and 3 (Books 5-12), and the *de Arboribus*) by E. S. Forster and E. Heffner, first published in 1954-1955. *De Re Rustica and De Arboribus* Book 4.1.1 and *De Re Rustica and De Arboribus* Book 4.1.2 . Classicists have repeatedly translated Pliny, when he quotes from Theophrastus describing the specification of rose propagating material, as "*quills, tiges*, *cuttings or saplings".*

The conundrum was also put before the Reverend Richard Smail, a leading Classicist from Oxford University.
"The problem with your three words is that they are non-technical terms being used in a technical context, and dictionary definitions in fact rely heavily on the translations you quote, because there aren't many (if any) other examples of usage.
Flagellum simply means a whip.
Mergus means something which dives (the commoner usage is for seabirds which dive into the water).
The meaning layer (for a vine) is based on the two uses by Columella (who was, after all, a gentleman farmer!) and one by the elder Pliny (who was a polymath, not an expert).
Mergus is an uncommon derivative of mergo, a verb which means plunge, dip, sink, bury, cover etc.

Vive/viviradix simply means having a living root.
I'm afraid that this isn't at all helpful, but I can't see a way of translating any of these words as sucker".

But there are Latin words for *suckers.* The translators of Pliny, Virgil and Theophrastus, Dioscorides and Columella, have translated *suckers* in the propagation of vines, as *stolones*, *vitulamen, or propagines.* Why then did they not use these words when translating how roses were propagated by *suckers*? Could it simply be that the translators were unaware that suckers were used in propagating roses as well as vines?

Pedantic this might seem, but because the literary review evidences that *Rosa x damascena* is propagated from *suckers,* certainly in Iran, Uzbekistan, Syria and Turkey, the hypothesis that the rose was able to transmigrate despite the heat and aridity of the growing terrain, remains valid. Finally, observations of the propagation of the Damask rose by *suckers*, observed during the field trip to Morocco described in Case Study 3, substantiates the literary review.

4.13 Case Study 3.

Cultivation of *Rosa x damascena* in Morocco in 2015.

This study opens up the issue of how the Muslims transported the material for the production of the Damask, from Central Asia and Persia, to the Mediterranean. The research has traced rose water usage in the traditions of the Sunnis and Sufis, the Ottomans, the Turkic people, the Egyptians and the Greeks. Conveniently, and far more accessible than Persia, modern day Iran, is the area where *R x damascena* is grown by the Berbers in the Sub Saharan desert, south of the Atlas Mountains, in Morocco.

The Berbers were the ancient, indigenous people of North Africa, west of Egypt. They were made up of many tribes, but nevertheless, co-ordinated their culture, their Hamitic languages, and considerable military power, during successive invasions of their lands. The Berbers were subjects of Islamic conquest following the death of Muhammad in 632 CE. (Brett 1997)[cxlv](Abun-Nasr 1997)[cxlvi] O'Shea 2006).[cxlvii] By 642CE, the Arabian Islamists controlled Mesopotamia and Egypt; they had invaded Armenia, and were concluding their conquest of the Persian Empire. It was at this point that Arab military expeditions into North African regions west of Egypt were first launched, furthering the spread of Islam to the West. Unlike the conquests of previous religions and cultures, the conversion to Islam by the Arabs was to have a pervasive and long-lasting effect on the Maghreb, the Arabic name for the North West part of Africa. The new religion penetrated nearly all segments of society, bringing with it armies, learned men, religious doctrine and fervent mystics. Faced with the *Jihad* against North Africa, the Arab Muslim aggression against the Berbers of Algeria, Tunisia, and Morocco, the nomadic Berbers were quick to convert, and assist, the Arab conquerors. (Westermarck 1926) [cxlviii]

No documentary evidence has been found to date the beginning of the cultivation of *R. x damascena* in the Dadès Valley near Ouarzazate in Morocco. This is an area which has a pre-Saharan bio-climate, and the relatively low temperatures suitable to rose growing. However local tradition, by word of mouth, says that cultivation was established by the Berbers at the time of their Islamic conversion to produce dried rose buds and rose water. Twelve hundred years later in the 1940's, French colonial perfumers built on the tradition, and built distilleries at Kalaat M'Gouna in the Dadès valley to produce rose oil and rose essence. Traditional horticultural methods of cultivation originate in antiquity, and rarely change from one generation to another. Was the method of cultivation in Morocco the same as that used in Persia? If so, was there proof, or at least evidence for, an Islamic or Persian horticultural technique, that had transmigrated west to Morocco with the Muslim demand for rose water production?

In Persia and in Central Asia, *R. x damascena* is propagated from suckers whereas in Europe and North Africa, roses are traditionally propagated from seed, or by budding, a specialised form of "T" grafting. An expedition in 2015 to Kalaat M'Gouna in Morocco was organised to establish which of the propagation methods described above [pp.65-67] were in operation in this remote area of North Africa, and how did

those methods compare with those used thirteen hundred years ago in Persia. Furthermore, could it be established that the mode of cultivation carried on by subsistence farmers in Morocco today could have been delivered by Muslim expansionists travelling to Morocco via the Silk Road? Examining current rose water production methods in Iran, Turkey and Bulgaria did not help because nowadays, these volume producers use modern methods and materials. However, further research into Iranian production showed that small groups of subsistence farmers still exist, who cultivate small plots that are not horticulturally viable for the mechanised large operators. [Fig. 62 p.67] These small farmers propagate the Damask, using the traditional methods of suckering. (Zahra Rose Water Co. 1978)[cxlix]

It was found that the propagation being practiced by the Berbers in 2016 in Morocco is exactly the same method being used in Iran today, where the traditional Persian regimes are still practised. Suckers occur on the roots of a plant naturally without man's intervention, they not require crafting or re-inventing. In neither country, despite that they are 10,000 kilometres distant from each other, has the method of cultivation changed. Therefore, it is not unreasonable to presume, that horticulturally the plant, its propagation, and cultivation techniques were introduced directly, or indirectly, from Persia. Further support to this hypothesis is that this method of propagation at Kelaat M'Gouna [Fig. 66, 67] stands in isolation amidst the surrounding regions of garden rose and cut-flower production, where the traditional European and North African method of propagating roses by "T Budding", is practiced. Fig.62 p.89]

Kalaat M'gouna & The Valley of the Roses

Kalaat M'gouna قلعةمكونة is located in the province of Tinghir and in 2014 had a population of only 16,956 (World Gazetteer 2014)[cl]. The small oasis town, a monument in itself to *Rosa x damascena*, [Fig. 68] is located at the base of the Valley of Roses in the Dadès Valley which is irrigated by the Asif M'Goun River. Rose cultivation takes place in two distinct, local, geographical areas: the first begins some ten kilometres from Kelaat M'Gouna village, and continues for a further ten kilometres north west, ending near the town of Boumalne Dadès. The second growing area, and by far the most important, begins at Kelaat M'Gouna and continues along a secondary road that climbs due north to the village of Bou Tharar. There are about thirty uninterrupted kilometres of rose cultivation along the wadi. This verdant valley, lying beneath an ochre canyon, is an incredibly beautiful landscape. Roses are a very important crop, offering the major source of income during a season which begins around the 10th April and ends around the 20th. May. An idea of the importance of the rose industry can be measured by looking at the number of shops in the town, virtually every other enterprise, sells rose water, rose oil, rose perfume, rose petals, rose everything …. The author does not speak Berber or Arabic, but does speak French, mercifully the second language of the old French colonial period. This allowed in-depth conversation with locals, from whom it was possible to ascertain the local methodology and horticultural practises on the rose nurseries, and in the distilleries.

[Fig. 73] Homage to *Rosa x damascena*, Town Square, Kalaat M'gouna

Propagation and Cultivation of R. damascena in the Dadès Valley

The whole Dadès valley is 'planted up' with *R. x damascena,* but not planted in rows in fields as nurserymen would do in northern Europe. Rather, the roses are planted as hedges that surround tiny areas of land each about half an acre (0.2 hectares). Small terraced fields [Fig. 69, 70], located along the sides of the river, are banked with low ridges of soil planted with 'simple suckers' or 'mound/stool layers'. The suckers are stripped from mature plants of *R. x damascena* and planted to form hedges that surround tiny half hectare fields [Fig. 72], in which are grown wheat and barley. These small fields, protected by the *R. x damascena* hedges, are fertilized each year with manure and composted plant material. Consequently, the soils are rich which, in the Dadès Valley, irrigated by the Asif M'Goun River, allows two grain crops to be grown each year. The first crop, barley is harvested by early July, the field is then ploughed and put down to wheat, which is harvested before the end of October. Much of the farming is still done by manual labour. Fields are cultivated using wooden or iron-tipped ploughs pulled by a team of horses, or a mix of horses, mules or donkeys. Crops are harvested by hand and once dry, are threshed by treading with teams of donkeys or mules. The soils consist of deep strata of clays and colluviums, which are easily differentiated by their colours which vary according to the geological content. They are slightly alkaline with pH ranges of between 7.4 and 7.8. The organic and nitrogen content of the alluvium is low, hence the need for manuring.

[Fig. 74]. *R. x damascena* Layered plant with unopened bud Kalaat M'Gouna, Morocco.

[Fig.75]. Small "field" growing wheat, Kalaat M'Gouna, surrounded by a hedge of *R. x damascena* Morocco. 2015

Propagation of *R. x damascena* is by '*layering*' or '*suckers*' (Fig. 74) taken in clumps from old hedges [Fig. 75], which are then planted out in 40cms deep trenches cut into the banks of soil from November to February [Fig. 77]. They are planted out in parallel rows, 45 cms. apart, the plants alternating with each other to form a dense hedge [Fig. 76]. Plants reach sufficient maturity to produce enough flowers to be able to harvest from Year 3. However, flower production increases with the age of the plant such that flower bearing hedges of 30 to 40 years standing [Fig. 75.] are common. Old plants display remontancy.

[Fig. 76] There are no flowers shown because they had all been picked earlier that morning. No photographs of the harvesting are allowed because Moslem women do wish to be photographed.

[Fig. 77]. 20-25-year-old hedge of Rosa x damascena in the Dadès Valley Morocco.

Irrigation, and feeding with potassium, phosphate and nitrogen is common practice but the use of sprays and chemicals against pests and diseases is practically non-existent. Pruning is rudimentary at best. The tools used are grubbing axes, sickles and anvil secateurs. The young plants are fertilised during planting to increase flower production, and also to avoid lateral root extension, using a basal dressing as rich as possible in organic matter, potash and phosphorus [Fig. 77].

The first flowering period extends from April to June and lasts between 25-45 days depending on the weather conditions, in particular the last frosts and the amount of rainfall. Distillers find that flower production is better in years when the first flowering period is short, (15 April to May 15). There is no picking from the repeat flowering plants, because the volume of flowers gathered is too low to warrant firing up the modern distillation machinery. Historically non-mechanised distillation pots could handle low quantities of pickings. Gathering flowers involves picking the barely open or closed buds by hand, which are then dropped into light jute sacks, a job undertaken by women and children. Each worker can harvest between 10 to 15 Kilograms of fresh roses per day. It is considered uncomfortable work on account of the thorns, and itchiness. This method of production is ideal for low volume production by subsistence farmers and a transient population. It solves the conundrum of how the Moslems could have sustained the production of rose water as they extended their geographical range. The Berbers make use of suckers that do not desiccate quickly, and strike easily.

Section 3.

Tracking the transmigration of the Damask rose from Central Asia to Rome.

Having established that the likely origin of *Rosa x damascena* lies in the watershed of the river Amu Darya, where it the first written records are from in circa 3500 BCE [p.78. Map 9], Homer (c. 740 – 720 writes of roses in the 8th. Century BCE, and that the rose appeared in Rome by 300 BCE [p.11], the thesis now turns its attention to how and why the rose transmigrated, and the route that it took. Consequently, this section investigates the passage of the rose over those 3000+ kilometres, and over 3000+ years; and who enabled that passage, and for what reason. The research for this thesis comes from two disciplines. A literary review of works by writers of the Classics that describe the nursery production process in detail. This is supported by a comparative study of the historic and contemporary production of rose water across central Asian into the Middle East and finally Rome.

The principal trading routes and the arterial roads used for long distance travel in Central Asia and the Middle East, over the period 3000 BCE and 300 BCE, evolved from the Assyrian trade routes of 3500 BCE into the Royal Persian Road, which in turn evolved into what are now known as the Silk Roads. During this research, it was found from studying Classical texts that the link between *Rosa x damascena* and its passage along the Silk Roads, was the cultivation of the Damask for its use in the production of rose water. This link was not at all obvious. Little is known of rose water in the West, much less how it is produced, and the traditions dating back to antiquity that surround the use of the product. Yet the volume of rose water produced both today and in antiquity is, and was, enormous. In fact, the production equated to the production of olive oil. The manufacture of rose water, and correspondingly the cultivation of the Damask, spread from the east to the west over the entire period from 3500 BCE, to 1400 CE.

Chapter 5.

Rose water

5.1 Introduction

Whilst it has proven possible to define a caveated point of origin for the Damask from phylogenetic analysis, and with botanical and geographical distribution maps, these data do not include the dates for the transmigration of the Damask. Research from Assyrian cuneiform tablets revealed references to the production of roses from as far back as 4000 BCE, followed by a plethora of references to rose water from the Latin, Greek, Persian, Syrian and Turkish writers from 1000 BCE. [See time-line p.132]. Since rose water is produced, principally, from the Damask rose, tracking the passage of the production of rose water corresponds with tracing the transmigration of the rose itself.

This thesis is concerned with the Damask as the prime source of petals for manufacturing rose water. However, one must be aware that there in fact, three species of rose, cultivated globally, for the production of rose oil. *Rosa x damascena*, the Damask rose, which dominates the industry, and is the rose most widely grown throughout the leading rose oil producing countries which are, Syria, Bulgaria, Turkey, Russia, Pakistan, India, Uzbekistan, Iran and China. Secondly, *Rosa centifolia*, the cabbage rose, which is more commonly grown, in low volumes, in France and Egypt. (Hass 2015)[cli]. Lastly, *Rosa rugosa* is grown to some extent in Japan and China. (Ueyama et al 1990)

5.2 Definitions.

Rose water, rosaceum, rose oil of antiquity and the rose oil of today, attar of roses.

The four rose-derived products most discussed in ancient texts are:

a) *Rose water*, flavoured water made by steeping rose petals in water.

b) *Rose confection*, or rose paste, called rosaceum, which is an unguent, a thick jam, produced by blending roses with sugar or honey.

c) *A rose oil cited in Islamic texts*, made by steeping roses in sesame seed oil, or olive oil, and then left in the sun.

Lastly, the *rose oil* we know today. This is the oil known as rose otto, attar of rose, attar of roses, rose essence or rose essential oil.

a) *Rose ottos* are extracted through steam distillation.

b) *Rose absolutes* are obtained through solvent extraction, or supercritical carbon dioxide extraction.

The oil bearing parts of the petal are the calyx and the white parts at the base of the petal itself. Little has changed; it appears from cuneiform tablets that Assyrian doctors were precise in their use of rose

water. *Penny Cyclopaedia* (ca. 1839)[cliii] includes details for various medicinal uses of rose, such as the petals of *R. damascena*. The buds were to be collected before they expanded. The calyx and lower parts of the petals were dried, with about 2,000 flowers yielding 10 pounds of dry petals.

Even with their high price, and with the advent of inorganic synthesis, rose oils are still perhaps the most widely used essential oil in perfumery today. The modern mass production of rose water, through steam distillation, was refined by the Persian polymath, Avicenna (980-1037 CE). He practised in the medieval Islamic world when, his experiments led to efficient, and more economical, uses for the perfumery industries [Fig. 74].

Very little has been written about rose water production and its history in the West, probably because, in the West roses, are considered a garden plant, not as a horticultural crop. Nevertheless, archaeologists have excavated Assyrian and Mesopotamian cuneiform tablets, together with extraction ewers dating back to 3500 BCE. Research has shown that Sumerians and Assyrians (1200 BCE) were among the first to have mastered the art of extracting fragrances. (Hűsnű-Can-Baser 2012)[cliii] Rose water was used as an agent for perfuming water, for holy water in religious services, in medicine and in cuisine and it is used in the production of rose oil, and attar of roses.

It was known as *golāb* in Middle Persian, and as *zoulápin* in Byzantine Greek. (Shahbazi 1990)[cliv] Assyrian tablets describe rose and rose water. (Thompson 1949)[clv] Cuneiform texts indicate that the roses were not directly distilled, but boiled with water to produce fragrant water.

5.3 Rose Water and Rosaceum in Antiquity (5000 – 1200 BCE) and in Islamic Expansionism

Rose oil and rose water are both obtained by the hydro-distillation of fresh rose petals. Most scholars attribute the method to the Arabian alembic, a process that dates back to the 9th century CE, but some authorities attribute it to the alchemists of Alexandria, from 50 BCE onwards. (Schmidt 2013)[clvi]. However, Schmidt also says that there is one record of distillation, in earthenware ceramic pots, from the Indus Valley civilization, 5000 BCE. The remnants of a distillation pot were excavated in Harappa, an ancient city of 2600–1900 BCE, in the Punjab. (Schmidt 2013)[clvii] This pot resembles the attar-production stills used to this day in Kannauj, India. The Kannui process involved firstly, the distillation of rose petals in water, then, trapping the resulting residue in sandalwood. One theory hypothesises that Mesopotamian clay tablets, and unearthed extraction jugs, dating back to 3500 BCE, show that the Sumerians and the Assyrians, had mastered the art of extracting fragrances. (Altintas 2010)[clviii] Assyrian tablets tell of rose and rose water. Of course, it is not possible to identify the rose species discussed in these ancient texts, but its scent is praised, suggesting fragrant rose species such as *R. gallica, R. centifolia, R. moschata,* or *R. damascena* of Anatolia. (Thompson 1949)[clix] Fragrant materials were submerged in boiling water for a day, and then drained. After adding oil, the

mixture was slowly heated. The perfumes prepared by this method by the Assyrians were 'world' famous. (Altintas 2010)[clx] Cuneiform texts also indicate that the roses were not directly distilled but boiled with water to produce fragrant water. The very small quantities prescribed — as little as one carat (3 grains) [0.2 g] — illustrate how precious it was.

Herodotus (c.485 BCE) says that a rose was cultivated in the Hanging Gardens of Babylon. Theophrastus (310-290 BCE) mentions the rose in seven passages in his *Book of Scents*.

In India, rose oil was named *Itr-i Cihangiri* (Jahangir's fragrance) after the Mogul Emperor Jahangir (1605 to 1627). According to legend, when Jahangir's wife, Nurjahan, was bathing in a warm water pond filled with roses, she discovered highly fragrant oil droplets on the surface of water. Another history claims that ponds of the Shalimar Gardens in Lahore, Pakistan, were filled with roses during wedding feasts. On hot summer days, oil droplets would cover the water's surface, emitting rose fragrance into the air. (Altintas 2013) [clxi]

Syrup could be made from the rose petals, but their chief use was in distillation; one hundred pounds of rose flowers yielded less than three drachs (c. 25 grams) of rose oil. According to (Flückiger and Hanbury 1874),[clxii] the classic world did not know how to distil rose oil. The rose oil described by the Greek physician Dioscorides, was a fatty oil in which roses had been steeped. This was used to make an unguent, a confection of roses, named *rosaceum*. *Rosaceum* was made from fresh, red, rose petals, which were beaten and combined with honey, and then rubbed together by hand. (Flückiger and Hanbury 1874),[clxiii] The Hittites of Anatolia (1750-1180 BCE) knew r*osaceum* as *pillu* and prepared medicines with it. (Baytop 1990)[clxiv]

Fig. Gathering red and white roses from Tacuinium Sanitaris based on an Arab treatise by the Christian physician, Ibn Butlan of Baghdad 15th. Century.

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A hieroglyph depicting a rose that was found in the tomb of the Egyptian Pharaoh Thutmose IV (1600 BCE), is the earliest record of the rose in ancient Egyptian civilization. (Flückiger & Hanbury 1879)[clxv] A wreath of roses

was later discovered later in an Egyptian burial chamber dating back to 400-200 BCE. (Flückiger & Hanbury 1879)[clxvi] The Egyptian queen. Cleopatra (69-30 CE), was said to have laid out rose petals in the path of Marcus Antonius (83-30BCE) so as to impress him. Christian Loeben, curator of the Egyptological collection of the Museum August Kestner has recently catalogued *The Plants of Ancient Egyptian Gardens* (Kappel & Kestner 2009)[clxvii]

There is a record of distillation in earthenware ceramic pots in the Indus Valley (5000 BCE). The remnants of a distillation pot were excavated in Harappa, an ancient city (2600–1900 BC) in the Punjab. (Schmidt 2013)[clxviii] This pot resembles the attar-production stills used to this day in Kannauj, India. The Kannui process involves the distillation of rose petals in water; the resulting distillate was then trapped in sandalwood oil (*Santalum album*) and the product called "rose attar" or "rose otto." [Fig. 85]

5.4 The Damask Rose in China

Confucius (551-479 BCE) the Chinese philosopher, wrote about the rose and its significance within the Chinese Empire. According to Confucius, roses were highly esteemed by the Emperor during the Zhou dynasty (1046-256 BCE). They were said to be planted in the Royal Gardens in China, and the Royal Library is supposed to have contained over six hundred books on rose and rose cultivation. (Altintas 2013)[clxix]. Despite that Chinese records show that rose water was being made from *R. rugosa,* further records from 810BC indicate that the province of Faristan in Persia, exported rose water to China, and throughout the Islamic world. (Scarman 2002)[clxx]

Interestingly, according to rosarian Charles Quest-Ritson there is no record of the Damask rose in China[clxxi] This seems unlikely in light of Scarman (Scarman 2002)[clxxii] and Ochir. (Ochir 2010)[clxxiii]. Rose water translates to **玫瑰水**, anglicised as *Méiguī shuǐ* in traditional Chinese. Ochir says that "Mei-gui Hua has been used as a crude drug in traditional medicine and as herbal tea in China. The scientific name of Mei-gui is *Rosa rugosa* thunb. However, the morphological characteristics and botanical ecology of Mei-gui were different from those of *R. rugosa*. Since the botanical origins of Mei-gui cultivated in China have not yet been clarified, we compared Mei-gui and *R. rugosa* in terms of their morphological characteristics, phylogenetic analysis, and phytochemical studies. Our research suggested that Mei-gui cultivated around Tarim Basin in Xinjiang Province showed homology to *Rosa gallica*, while those cultivated in the north eastern parts of China are considered to be hybrids of *R. rugosa*.

The question over the presence of the Damask in China requires further research, starting with tracing the parentage of Tarim Basin *Méiguī* as opposed to the north eastern Chinese, *Mei-gui.* Once again, it appears that taxonomic synonyms are causing confusion. Could it be simply a question of the Chinese Damask being lost in translation and botanical definition?

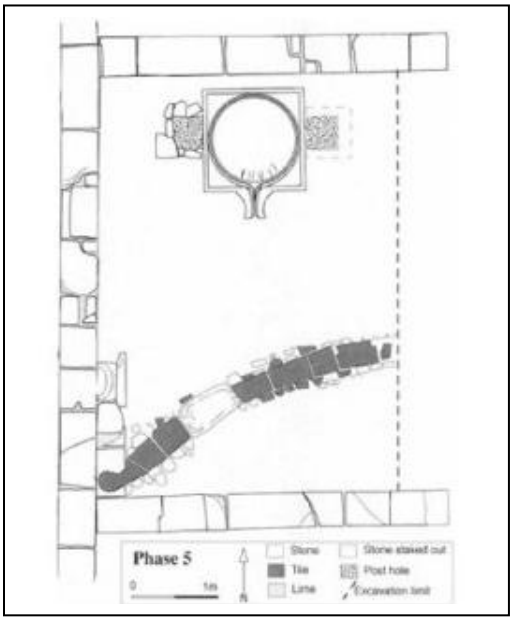
5.5 Rose Water and Rosaceum in Classical Rome and Greece (1200 BC- 400AD)

The significance of rose water in Roman domestic hygiene

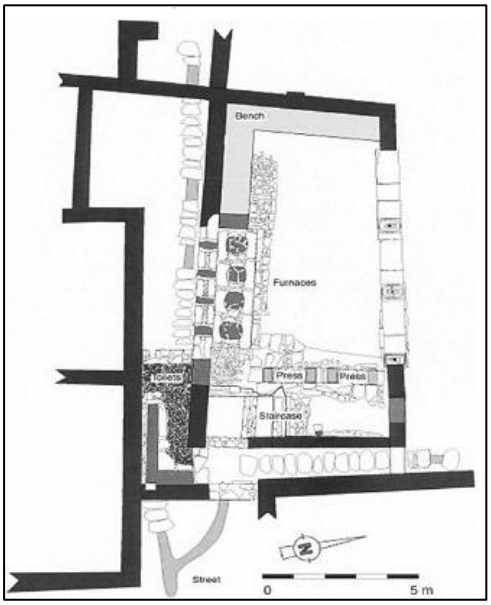
The Romans and peoples of the classical world were to put it delicately, smelly. In fact, eye wateringly, pungent smelly. The hot Mediterranean climate and constant physical exertion in the absence of machinery, predicated for hot and sweaty, smelly bodies. Furthermore, the smells from the remains of popular gladiatorial and animal blood-bath games must have been over-powering. Open-air Roman markets must have added to this sensory assault. The fly-infested fish and meat quickly turned rancid. It's no wonder Romans made liberal use of heavily fermented fish sauces to hide the taste of deteriorating foods. Furthermore, Roman religious' festivals required a daily blood sacrifice of at least one bull, sometimes dozens of them. The smells of human carcasses, also burning by the hundreds, constantly filled the air. Despite this foul-smelling atmosphere, the ancient Romans are widely admired for what appears now to be an enormous commitment to hygiene and public health. They built vast sewer systems, such as the very grand *Cloaca Maxima*. (Koloski-Ostrow 2013)[clxxiv] .Grant, (Grant 1992)[clxxv] indicates however, that hygiene in the Roman World was limited only to the rich and famous. (Grant 1992)[clxxvi] Grant's research has revealed that the Roman's Cloaca, and other cities' sewer systems, weren't constructed primarily for the removal of human waste. They Sewers moved odoriferous water, away from urban development and industry, but they did not contribute much to urban sanitation. The olfactory senses fade very quickly. In fact, noxious smells extinguish within seconds or minutes (Greenberg 2013)[clxxvii]. Smells are one thing, but stench is quite another, which is why the ubiquitous use of rose water was so very important to quell the olfactory senses.

5.6 Rose Water and Rosaceum Production described in Classical Roman and Greek texts and archaeology.

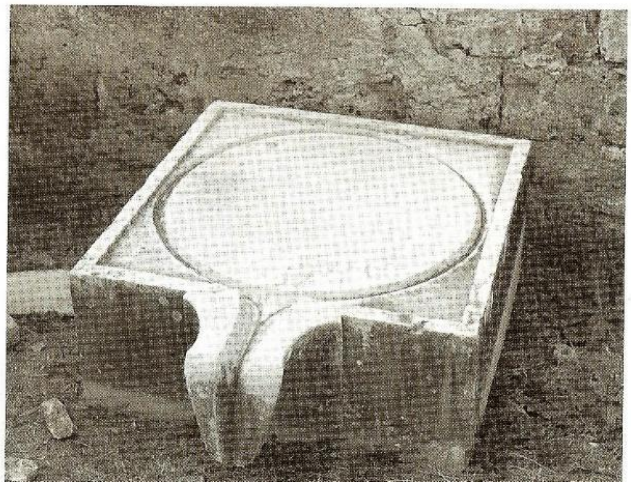
Rose unguent (*rosaceum*) had been manufactured in Greece since antiquity. The tradition was described by Homer in the Illiad (XXIII, 186-7)[clxxviii] when the corpse of Hector was massaged with 'divine rose oil' (the oil of the ancients not modern rose oil) and in a similar vein by Hippocrates (Lazarrme 1729) [clxxix]. Pedanius Dioscorides (40 – 90 AD) author of *Materia Medica* (Le Wall 1915) [clxxx], a prime historical source of information about the medicines used by the Greeks, Romans, and other cultures of antiquity, dedicates Chapter 43 of his *Materia Medica* (Le Wall 1915) [clxxxi] to the healing properties and manufacture of rose unguent. The rose water was manufactured in workshops constructed expressly for the purpose [Figs. 70, 71] (Brun 2000)[clxxxii]



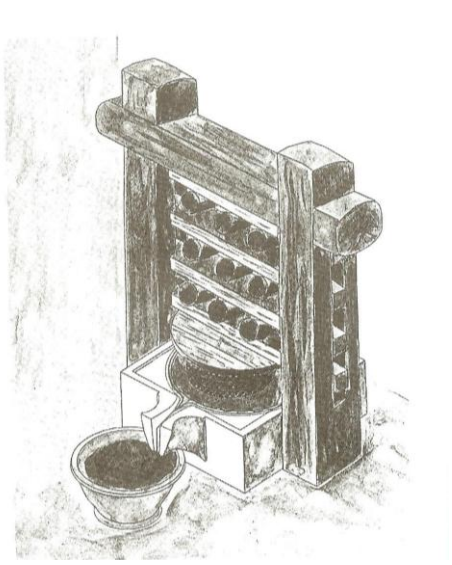
[Fig. 75.] The plan of the Paestum building (IB) in the vicinity of the stadium (Brun 2000)[clxxxiii]



[Fig.76]. Plan of the work shop in Paestum (Brun 2000)



[Fig. 77] - Paestum. Marble base of winepress in the perfumery workshop It was intended for both Olive oil pressing and for use in the manufacture of perfumes (area of the Forum, N-O angle). (Source: Brun, JP, 2000 P. 292)



[Fig. 78]. Sketch of a working model of Fig.88 (Brun 2000)[clxxxiv]

[Fig. 79] Workshop manufacturer of perfume, Casa dei Cervi, Herculaneum ((Brun 2000)

Theophrastus (c.372-c.287) is the first significant source for descriptions of scents and fragrances in antiquity. He describes making rose perfumes in his *"Enquiry into Plants (volume II)* Concerning Odours" To make rose perfume they use ginger grass *aspathalo*s, and sweet fig. These are steeped as in the case of the Greek tree *kypros.* The root of the *alkanet* also contributes to the colour of rose perfume. Salt is used in its manufacture as a preservative. The rose even reawakens the effect of compound perfumes; for when the flowers is at its best they treat compound perfumes with it; and when these come to be opened, they smell only of or chiefly of rose. The admixture of rose perfume, whether in scents or flavours, if it be well blended, is beneficial in the one case by removing the heaviness and strength of the scent, in the other by imparting a fragrant scent or sweet taste to the flavour as in the case of wines".

Dioscorides (90 AD) three centuries later describes the manufacturing process in greater detail. (Le Wall 1915)[clxxxv] "First of all, boil up, five pounds, eight ounces of reed. Shred the cooked reed by stirring the canes and put the macerated concoction to soak in water. Then add twenty pounds, five ounces of oil to the reed. Dioscorides makes a point about the quality of the oil and its ability to extract and retain the 'essence' of the roses. His preference was for oil made from green olives (Dioscorides *Materia Medica* Vol I, p. 30[clxxxvi]). After cooking, the oil had to be filtered. The ungenteur covered his hands with honey, and would repeatedly mix the paste, pre- pressing the mix gently. After leaving the mix to macerate for one night, it was ready to press. Once the sediment had settled on the bottom, the remaining oil was decanted, and then preserved in an amphora strewn with honey. [Figs. 72, 73, 74]

The principle difference in the methods described by Theophrastus and Dioscorides is how the pressing from the rose petals were preserved. Theophrastus describes the use of salt and steeping in oil flavoured olive oil. Whereas Dioscorides, there hundred years later describes a far more sophisticated method by which spongy reed is used to absorb the pressing from the petals, before they in turn are pressed.

Both Pliny (XXI, 112-120)[clxxxvii], and Dioscorides are explicit when it comes to the best variety of reed even down to the best forms of the stems and canes. They both identify the best varieties and their characteristics. Their preference is for the fragrant' (Pliny "*iuncus odoratus*", XXI, 120; cf. X, 104)[clxxxviii], which when crumpled, gives off a scent of roses (*in confricando odorew rosae emittit rubentibus fragmentis*". Pliny notes that the reeds growing in Italy (XVI, 157)[clxxxix], "have a spongy structure and tend to absorb liquid well, which allowed

better thickening of the rosaceum". The rosaceum, the unguent or ointment, was now ready for the introduction of the first pressing of rose petals. Just the base of the petals and calyx were used. This first pressing was the most highly sought. Dioscorides (Dioscorides *Materia Medica* Vol. I, 30[cxc]) go on to say that the process could be repeated up to ten times, each subsequent pressing producing a lower quality product than the one before. Eight pounds three ounces of the condensed oil (*Ec; tuuuévou*), was poured over the pressed petals, and a layer of honeycomb spread between each pressing. To proceed with a second pressing of the rose petals *(éY1ßoÄ1i)* Dioscorides says that "thousands of fresh and dry roses, again shuffled with hands impregnated with honey, must be introduced to the first pressing. Likewise, the third and the fourth, and so on, always using dried flowers and always sprinkled with honey". The original maceration was effectively renewable with fresh rose petals for a period of seven days, particularly with the addition of salt. In Chapter 113 of *Materia Medica*, (Dioscorides *Materia Medica* Chapt.I13[cxci]).

Dioscorides (90AD) also explains the process for the extraction of the juice from the fresh rose petals. "After the white bases to the petals were cut out, they were to be pounded in a mortar and the juice that was produced left in the shade to condense". There are commentaries from other writers. Aetius, (Olivieri 1935)[cxcii] recommends "the use of the white bases of red rose petals, which are then left to dry for a day and a night. Then in well-defined proportions the petals are put in olive oil made from immature olives, *omaphacium*. This is poured into vessels, covered with a linen cloth, and left outside in the sun for several days but no more than forty". Alternatively, the vessels could be kept suspended for forty days in a well of cold water. (Mello 2003)[cxciii]

5.7 Rosa centifolia, Rosa phoenicia, Rose Water in the Levant and Islamic Expansionism

Thus far, this thesis has only considered rose water production along a route running from the Amu Darya Water shed in modern day Uzbekistan to ancient Greece and Rome. There is a second possibility, albeit unlikely, that is that rose water production started in the Levant and Eastern Mediterranean using the species *Rosa centifolia* and *Rosa phoenicia*. (Widrlechner 1981)[xl] The hypothesis in part, is not perhaps entirely unfounded if one considers the possibility of *Rosa centifolia* as being a hybrid, a form or even a variety of *Rosa x damascena.* Both plants prevail through the Levant and Mediterranean are very similar. In support experience of the author shows *Rosa x damascena* is polymorphic varying enormously in the size of its flowers and the number of petals. On the rose nursery, a row of 500 plants will show considerable variation. *Rosa phoenicia* is very similar to f *Rosa x moschata,* so similar morphologically that it could well be a form of the polymorphic *R. x moschata* which we know to be a parent of *R. x damascena.* DNA analysis in the ongoing research programme described above [Page 42] should clarify the issue.

There are further possibilities. Suzanne Amigues wrote an excellent commentary (Amigues 2010)[cxciv] in respect of comparisons of specie and hybrids of the Mediterranean region described by Theophrastus who describes roses with smaller, less fragrant but very double flowers. She goes on to say that Herodotus

describes roses in the gardens of the son of Midas that have sixty petals and have a perfume that surpasses all other roses. Furthermore that these roses resemble *R. gallica* in respect of their sepals, thorns and hips. There appears little reason not to presume that *R. gallica* was involved in the Mediterranean hybrid much as it is in the hybrid *R. x damascena* of Central Asia. Indeed they as hypothesised above, they may well be the same.

Meanwhile, aside from determining parentage, what is interesting is how the rose water producing hybrid be it the *R x damascena x R. gallica x R. moschat*a hybrid, or even if it is in fact a *R. centifolia x R. phoenicia* hybrid, spread around the Mediterranean. Robin Lane-Fox describes in his *Travelling Heroes* how Homer plots the sea routes used by the great maritime Mediterranean travellers the Phoenicians. Evidence from archaeological finds of *unguentaria*, small ceramic or glass bottles have been found distributed throughout the eastern Mediterranean.

Bronze Didrachm coins from Rhodes 166-86 BCE depict a single rose with long petals, a small calyx and a bud borne on what could be construed as immature climbing growth. (American Numismatic Society 19001949/1941.153.870.rev.width350.jpg). Wild roses (single flowers) flourish on Rhodes, one being *Rosa phoenicia*. This rose was known to the ancients, and is still found scattered in numerous localities in the Troad and Syria. (Carter 2015) W. L. Carter Roses in Antiquity Volume 14, Issue 55 September 1940, pp. 250-256 Rosa *abyssinca* thought to be a hybrid of *Rosa gallica* and *Rosa phoenicia* is another possibility, as is *Rosa richardii* once known as *Rosa sancta.* Another coin. (American Numismatic Society 19001949/1941.153.870.rev.width350.jpg). appears to depict a semi double rose. Theophrastus (d.287 BCE) describes roses which he writes, vary in number of petals, roughness of bark, colour and scent; they have five, twelve, twenty or more petals, and those with the sweetest scent come from Cyrene, and are used for making perfume. He lists the times of flowering of different roses. The identification of the roses on these coins becomes further complicated if hybrids selected by man are included in the list of possibilities.

Until such time as the research project 'The evolutionary genetics and taxonomy of *R. moschata* and *R. phoenicia'* has determined a phylogenetic table for the species and naturally occurring hybrids of the Levant, North Africa and the Eastern Mediterranean, attempts at identification can only be speculative because currently the options are unknown.

Meanwhile, the Damask rose translates into Persian as the Muhammadan rose, *(gul-i Muḥammadī)*; rose water translates as (*gulāb);* and rose oil translates as (*'aṭr)*. Allegedly, rose water obtained its Arab name, from the Islamic legend that the rose was created from the drops of perspiration, that fell from the forehead of the prophet Muhammad during his miraculous, nocturnal ascent *(mi`rāj)*, through the seven heavens, to the Throne of God. Islamic accounts hold that the Prophet exhibited a characteristic feature of sanctity, in that his body exuded a fragrant odour. A further association of the rose with Islam's Prophet, is the depiction of the Muhammadan rose (Conran 2007)[cxcv] with the ninety-nine epithets of Muhammad inscribed on its

petals. According to medieval sources, the finest quality rose water in the Near East was produced in Shiraz, in the southern Iranian province of Fars. In the high caliphal period, circa ninth century, the province of Fars was known to have sent thirty thousand flasks of rose water and one thousand measures of rose honey to the 'Abbasid' treasury in Baghdad as part of its annual Tribute (Subtelny 2007) [cxcvi]

5.8 Rose Water production in the Turkic Cultures of Turkey and Syria

In the early history of Central Asian Turks, sources tracing the Turkic use of rose water reach back only as far as the 11th century. (Altintas 2013)[cxcvii] Two lengthy works written in the 11th century, mention the use of rose in Turkic societies. In *Kitab-u Divani Lugat-it Turk (The Dictionary of Turkic Words)* by Mahmud Kashgari (1005-1102) from Kashgar, describes Ugdulmish, the vizier's son, advising Odgurmish, the ascetic, on "the rules of conduct at a banquet," He suggests that Odgurmish offers *culab* and *culengebin* syrups prepared with rose water. The aforementioned text confirms that the Turks were preparing syrups using rose water since the 9th. Century AD. (Yusuf Has Haji 1988)[cxcviii] In *The Dictionary of Turkic Words*, Mahmud Kashgari refers to "a copper rose-water vessel as *kumgan*", and therefore had a word for it in their language. Supporting the fact that Turks were making rose water.

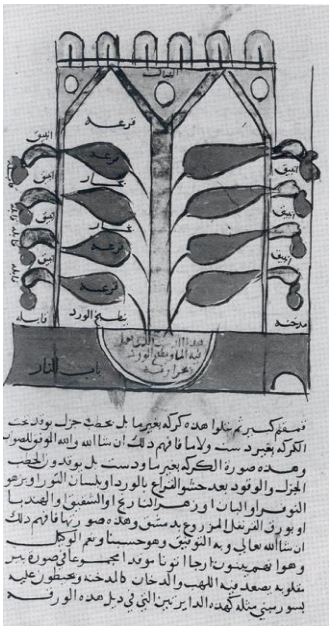
Further investigation of the word *kumgan* reveals significant historical information. Cosmographer and geographer Al-Dimashqi (1256-1327) [cxcix], a prominent scholar of the 13th century Muslim world, notes the important centres of rose-water production in the Middle East in his book *Nuhbetu'd-Dehr fî Acaibi'l-Berr ve'l-Bahr (Important Interesting Creatures of the World's Lands and Seas)* [cc] Al-Dimashqi particularly emphasises an important rose growing centre in Syria, called Mezzeh. He describes the art of making rose water as practiced in Mezzeh as follows: "The storage vessels were filled with roses, and then the alembics were put in their places. When each alembic was filled with rose water, the rose water was poured into huge glass jugs, or into copper vessels with two handles, called *kumkum*." (Ebi Talib el-Ansari ed-Dimashqi, 1988)[cci] The term, used by rose water manufacturers in Mezzeh, sounds much like *kumgan*.

In Isparta, the centre of modern-day of rose cultivation in Turkey, the special vessel with a narrow mouth in which distilled rose oil is stored, is still called a *kumkuma*. The word is also used colloquially in the saying "*gossip kumkuma*," which alludes to gossiping women. That the word for the copper ewer holding rose water,' *kumgan'*, was in use for 900 years, illustrates the Turkic tradition of the production of rose water. Anatolian Seljuki Turks used motifs of rose, rose water, and rose oil in their literary works [Fig 91] and called rose water tradesmen, the manufacturers, the, *gulab-ger* (Mercil 2000)[ccii] . The 13th century Persian poet and mystic, Rumi (1207–1273) also mentions *gulab-ger* in his *Divan-i Kebir*: "Wake up, the artisan is making rose water, like sweat oozing out, be free." (Rumi 2005)[cciii] . Ibn Battuta (1340-1369) provided one of the earliest sources of information on rose-water production in Anatolia. He wrote about the rose water produced in Nusaybin, near Mardin, south east Turkey, in 1330: "The rose water produced in this region is unique in its

fragrance and its taste." He also describes the tradition of using rose water after bathing in the *hamam* in Ladik. (Ibnul-Baytar el-Mufredat 1842)[cciv] . A study of an Ilhanate city in the Mongol Empire in ancient Persia, cites sources that discuss a "rose house" (*gülâb-hane*) beside the hospital. In the city, newly discovered in 1309, the rose-water manufacturing shop was one of the still standing buildings. (Özgüdenli 2013)[ccv] The same sort of facility was observed in the Ottoman city of Edirne, where the *Darussifası*, the hospital, founded in 1488, also had a *gülâb-hane*, or *gulhane*. Official documents dating from 1489 note, "There are three lead furnaces for making rose water." (Gökce 2000)[ccvi] Since rose water was used abundantly in the hospital in those days, the expenses of making rose water in the *furun-i gul*, the rose water boiler, were accountable." (Gökce 2000)[ccvii]

5.9 Traditional methods of rose water manufacture in the Islamic world [Figs. 81, 82, 83].

[Fig.80] Miniature portrait of Mehmed II 1432 – 1481 smelling a rose. (Pic. Courtesy Nurham Atasoy). Note the rose is double, denoting it as a hybrid and therefore, a form of R *x damascena,* in all probability.



[Fig.81] A distillation plant in Damascus consisting of multiple units for producing rose water (13th Century) (Yassan 2011)

[Fig. 82].1-4. Traditional technology and equipment used for the manufacture of rose water and rose oil 780BCE (Haghighi & Tehranifar 2008) [cii] Note the similarity with the equipment used in Morocco Fig. 100

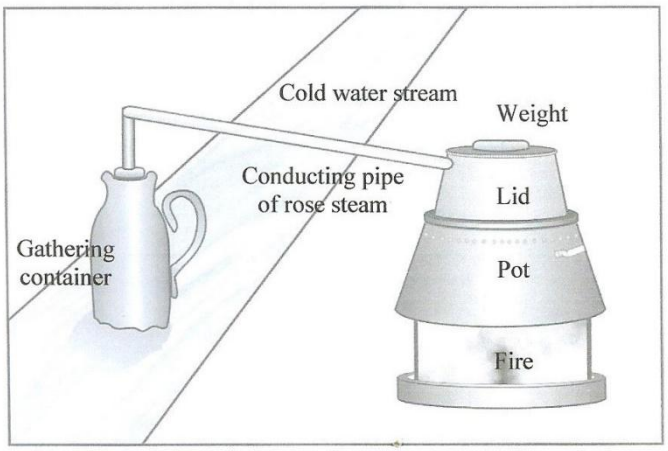


Fig. 1. Traditional system for rose distillation.

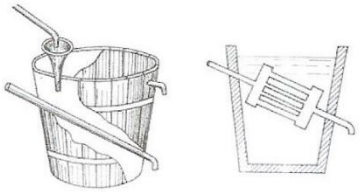


Fig. 2. The vapors are cooled in a special unit consisting of a wooden cask.

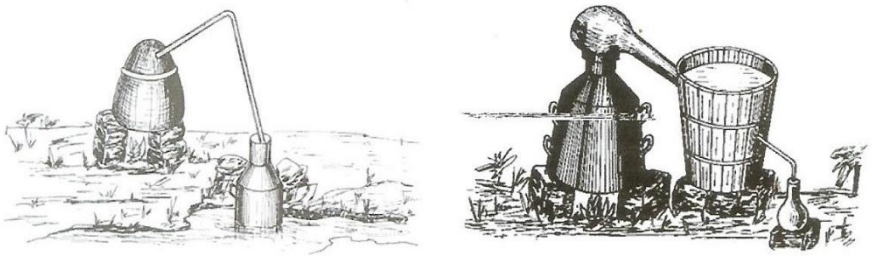
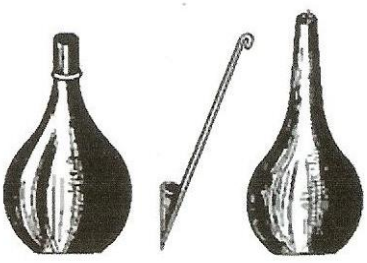


Fig. 3. The Iranian type of alembic.

ccviii

Fig. 4 The oil is then liberated in the neck of the receiving bottle, the *surier.*



5.9 Case Study 4.

Rose Water Production in Morocco

The Moroccan production process.

Rose oil is made in Morocco by steam distillation using the same method that is used in Syria, Turkey and Iran. [Fig. 84] This method, involves passing steam through the plant material containing the desired oils. Steam distillation is a special type of distillation, [Figs. 85, 86] a separation , used for *temperature sensitive* materials. Dried petals [Fig.87] are also produced in volume, for medical and culinary use.

[Fig.83]. Rose fields. Kalaat M'Gouna – Nicholas 2015

[Fig. 84]. Kalaat M'Gouna – Traditional method of rosewater production. 2015

[Figs. 85] Distillation tanks
for rose oil production Kalaat M'Gouna 2015.

[Fig. 86] Distillation tanks Kalaat M'Gouna 2015.

[Fig.87] Dried rose petals. Kalaat M'Gouna 2015.

[Fig.88] Selection of bottled rose water. Note the antique rose water bottle, the *Ashkdan,* on the right. Kalaat M'Gouna 2015

Production of rose water in Iran and the Persian Empire

Iran supplies 90 percent of the global demand for rosewater. During the medieval period the finest quality rose water was produced in the region of Shiraz in the southern Iranian province of Fars. From here, it was exported to all parts of the world, including Egypt, India, and China, where it was referred to simply as the "Persian rose" *(gul-i fārsī)*. The large cultivation area of Damask rose in Iran represents a potentially rich source of genetic resources for the species. To explore the diversity, Damask rose genotypes from various cultivation areas of Iran, and one from Bulgaria, were evaluated with 37 simple sequence repeat (SSR) markers and characterized for 10 morphological traits and their ploidy levels. A total of 224 bands were scored from 37 SSR primer pairs. UPGMA cluster analysis based on Dice genetic similarity revealed 11 distinct groups for SSR and only three for the morphological data. Although most of the Damask roses were tetraploid, one triploid, and two hexaploid, genotypes were also found. The discriminating power of the SSR data was similar to previously reported data from RAPDs. The high level of molecular diversity revealed in this Iranian collection of assessions of *R. x damascena*, suggests that the modern day Iranian sector of the Persian Empire of antiquity, is the probable centre of diversity for Damask rose. (Kiani et al 2009)[ccix]. Geographically, it is close to the river Amu Darya watershed.

Map. 12: Map of Iran showing the five important provinces of Damask rose production and the locations Iranian Production (Kiani et al 2009)[ccx]

Every year during the second half of May, the *Golabgiri* festival of rose and rose water is held in Kashan (RussianExim 2015)[ccxi] The season for picking rose and preparing rosewater is from early May to mid-June. Production of rosewater in Iran dates back to over 2,500 years (Houtum-Schindler)[ccxii] who maintains that an East Roman official picked some roses from the slopes of Kooh Asbi mountain near Qamsar [Fig. 86.] and took them to Damascus. Maybe he did! The author has found no evidence in support of this myth, which might possibly be found in Iranian literature.

[Fig. 89]. Looking S/SW from the summit of Chapakro the distant peak on the right is Atash Kooh 3713 m. In front of and to the left of it: Asbi Kooh 3819m. Source http://www.summitpost.org/atash-kooh-asbi-kalak/ 230753 June 15, 2006.

[Fig. 90] Traditional harvesting varies little. Iran 2014

Method of Production of Rose Oil in Iran

After planting, the rose suckers take at least 3 years to attain maturity. A mature rose field normally yields 5 tons of fresh roses per hectare. However, in a carefully nurtured field, the yield may increase to 7-to-8 tons per hectare. It is normal for a field to be productive for as long as 20 to 30 years. Roses are handpicked in the early hours of the day and transported to the 'factory'. [Fig. 90] A skilled worker can pick about 40 kg of roses in 8 hours. The factories remain open 24 hours a day, for one month. When the season is over, the factories are cleaned and closed down until the next season. In village-type distillation, [Fig.91] freshly picked flowers [Fig. 89] are loaded into 150 to 1,000 litre copper or galvanized steel, open fire, stills; most stills have a 300 litre capacity, and consist of a retort and a head. The removable spherical head is connected to a pipe, which leads through a pool filled with lukewarm water to cool the condensate. At the outlet, there is a 9 litre glass collecting flask. Typically, 10 kilos of flowers and 60 litres of water, are loaded into 300-litre stills, and are distilled for 1 to 2 hours in order to collect two flasks holding 18 litres of the distillate.

[Fig. 91]. Village-type rose oil distillation facility in Iran.

[Fig. 92]. Village woman. Kashan, Iran 2014

The oil does not separate due to the low concentration of oil in the distillate. Therefore, about 60 litres of the distillate is redistilled, yielding another 18 litres of distillate, from which the oil that floats to the top, is decanted. The aqueous phase is diluted with distilled water and marketed as rose water.

Generally, industrial production employs larger 3,000 litre copper or stainless-steel stills. Each still has a charge size of 400 to 500 kg flowers and can hold 1,500 to 2,000 litres of warm water. The stills are steam-jacketed, that is, they contain an inner double-wall inside in which steam is circulated. There may also be provision for the injection of live steam into the still to speed up distillation. The distillation process takes one and a half hours. The condenser temperature is kept at 95°F (35°C) to avoid the solidification of waxes. The distillate is collected in 200 litre stainless-steel Florentine flasks. The oil that separates out is called crude oil, first oil, or direct oil. Distillation is terminated when the distillate no longer has a bitter taste. The overflow of the Florentine flasks is collected in 500-litre tanks. These 'bottom waters' or 'first waters' are then pumped into 5,000 litres, stainless-steel still tanks. The *'bottom'* waters are cohobated, that is they are distilled again.

This time in 3,000 litre stills, for 1 to 1.5 hours to obtain what is called the second oil, cooked oil, or indirect oil. The distillate that remains after oil removal is sold as rose water [Fig. 104]. The first and second oils are filtered and kept in glass flasks in the dark. When the production season is over, the first and second oils are mixed to yield rose oil and packed in special 2 to 5 litre, tinned-steel containers. Generally, 3.5 to 4 tons of flowers yield 1 kg rose oil which equates to about 0.02%.

Iranian Rosewater production equipment

Comparisons have been drawn to assess the similarities between production in Morocco and Iran. The equipment used for the extraction of rosewater in Qamsar, Iran [Table 22] has hardly changed over 1500 years, it includes:

1.	A copper pot with a capacity of 120-150 litres.
2.	A big clay pot is used to cover the copper pot. A major advantage of clay pot was that it did not burn the fragrance of the flower.
3.	A copper pitcher with handle and a capacity of about 30-40 litres which is used to add cold water, so that flower nectar and sap are turned into liquid.
4.	Four wooden stakes which are attached to each other to connect the pot to the pitcher; today, aluminium pipes are used instead of the timber.
5.	A water pool for the liquefaction.
6.	Oil or diesel fired heating equipment under the copper pot. In the past wood and dried shrubs provided the fuel for the heating process.

Table 15. Equipment used for extraction of rosewater in Qamsar 2016.

First the copper pot is put on an oven made from bricks and cement or stones and mud. The heating equipment is positioned below it. Up to 30 kg of rose petals are then poured into the pot and 80 litres of water is added. The pot is then covered, and a heavy weight is put over it to control steam pressure. Probable holes and cracks are covered with a mortar made of the remnants of boil flowers and bread dough to prevent loss of steam. Nowadays instead of weight and dough, the nurserymen use elastic washers, screws and levers. The copper pitcher is put into the water and is kept in place by a ladder, or by cast iron pipes, so that it does not surface. Then canes or aluminium pipes are inserted into the pot, on the one side, and into the pitcher; on the other side they are held fast and wrapped it in a piece of cotton, so that water does not penetrate into the pitcher. Water or any other foreign object will ruin the rose water. Preparation complete, the oven is fired to boil the pot. At that time, rose water and water steam rise up the pipe as far as the angle. From there, rose water steam continues toward the pitcher and condenses. It takes about four hours before a pitcher full of rose water (40 litres) is obtained. The rose water is poured into bottles and allowed to cool down. The waste collected at the bottom of the pot, which is called ‘bongol’, is used to feed livestock, and is also dried for use as fuel in winter, or as fertiliser for gardens. The quality of the end product is dependent on a steady, moderate flame. Or, in other words, the longer the distillation period and the steadier the flame,

the higher the quality of the end product.

This chapter of the research was successful, in so far that it provides possible evidence that the traditional means of propagating *R. x damascena* by the ancient method of suckering, or layering, in the small subsistence farms in remote Iran, is mirrored by the methods used by the Berbers in remote Morocco today. This is a propagation method that stands in isolation in Morocco, where "T" budding would be the first choice of nurserymen growing a crop of modern day garden roses. Furthermore, 'Suckers' are easily transported in the hot, arid climates by packing the propagating material in moist sacking, or carpet, to avoid desiccation, and in which they can survive for weeks, if not months.

5.10 Rose water Pharmacology

References to Rose water in Islamic Medical Texts

The tradition in Persia of using rose water, rosaceum and early 'rose oils' was recorded far earlier than the advent of Islam about 2000 BCE. (Baytop 1990)[ccxiii]. Detailed Persian records are scarce until the Arab thinker, Al-Kindi, in the 9th century BCE noted that he prescribed rose water products for stomach pain, ulcers, liver and mouth diseases, and sore throats. He also used rose oil for burns, ulcerated wounds, and as an ingredient of haemorrhoid salves. (Levy 1966)[ccxiv] . Al-Dinawari's (9th century BCE) texts noted the refreshing effects of rose water, and recommended it for fever. He also recommended the application of rose oil to the head for alleviating fever and due to its calming effects. (Altintas 2010)[ccxv] Abu Bakr Mohammad ibn Zakariya Al-Razi (Rhazes), the 9th century Arab physician, called attention to the therapeutic value of rose and stated that "the rose diminishes drunkenness." (Levey 1966)[ccxvi] The great polymath Ibn-i Sina Avicenna, (11th century CE) was the first scientist to emphasise the Damask rose fragrance's beneficial effects on the heart and the brain. He said "Because of its exquisite fragrance, the rose addresses the soul," Furthermore, he wrote, "It has a calming effect and is highly beneficial for fainting and for rapid heartbeats." He praised rose water's effects on mind and spirit. "It enhances comprehension and strengthens memory." (Abd Allāh ibn Sīnā – Latinised name Avicenna 980 1037 CE)[ccxvii] Like Ibn-i Sina, Ibn-Al-Baitar also noted rose water's beneficial effects on the brain: "Rose water strengthens the mind and the brain, sharpens the senses, and increases the life force; it is beneficial for rapid heartbeats due to anxiety; because of its beneficial fragrance, it empowers the body."(Ibnul-Baytar el-Mufredat 197–1248)[ccxviii] Ibn-AlBaitar also stated that boiling rose water, and exposing the head to its steam had healing effects and that it was especially beneficial for eye diseases. He also recommended inhalation of the steam to alleviate drunkenness and headaches. In his famous medical book *Kemaliye*, Mahmud of Shirvan (15th century BCE) described a powder prepared by crushing dried rose petals in a mortar for application to the neck, breast, and armpits after bathing, so as to impart a favourable smell to the body and to "treat the spirit." He claimed that this scent empowered spirituality and purified the heart. He wrote that "the fragrance of rose is the fragrance angels like." (Sirvanli 1430)[ccxix] The same powder

also is mentioned in the *Edviye-i Müfrede* which translates as *Simple Drugs*, of Ishak bin Murat (14th century BCE) for use in Turkish baths. It was said to be beneficial for those suffering from scabies. If rubbed on pimples, it reportedly cleared them. (Geredeli Ishak 1387) [ccxx] Salih bin Nasrullah (17th century CE) said of rose water in his book *Gayetül Beyan* trans. *Human Health and Sanitation Techniques*, that when rubbed on the body, it gives a pleasant smell, and when rubbed on the head, it alleviates headaches. He also wrote that, ground, dried rose petals can be rubbed on mouth ulcers to alleviate pain. It is reportedly, also beneficial for smallpox or measles lesions if sprinkled on the skin. (Nasrullah trans.1991)[ccxxi]. A review paper [Table 14] on the pharmacological effects of *R. damascena* has recently been published. (Boskabady 2011)[ccxxii]

Table of ailments treatable by rose water

[Table 16] Pharmacological Activities of Rose Materials (Boskabady 2011) [ccxxiii]

Type of Extract/Essential Oil	Activity Shown	Technique	Reference
Aqueous and/or ethanolic extract	Hypnotic	Pentobarbital-induced sleep time	41, 42
Aqueous and/or ethanolic extract	Analgesic	Hot plate, tail flick, acetic acid, and formalin tests	43, 44
Aqueous and/or ethanolic extract	Antitussive	Citric acid method	45
Aqueous and/or ethanolic extract	Bronchodilatory	Inhibition of calcium channels of guinea pig tracheal chain	46, 47
Aqueous and/or ethanolic extract	Potentiation of heart rate and contractility	Isolated guinea pig heart	48
Aqueous and/or ethanolic extract	Anti-inflammatory	Carrageenan-induced rat-paw edema	45, 49
Aqueous and/or ethanolic extract	Laxative Constipation	Rats by gavage and intraperitoneal injection	50
Aqueous and/or ethanolic extract	Anti-solar	Sun Protection Factor (SPF) determination	51
Aqueous and/or ethanolic extract	Antiaging	Mortality rate in adult Drosophila flies	52
Ethanolic extract (*R. centifolia)*	Antitussive	Mouse model induced by sulphur dioxide gas	53
Hydroalcoholic, ethanolic extracts, and essential oil	Antioxidant	Measurement of free radical scavenging activity	54-56
Methanolic extract	Antidiabetic	Measurement of a-glucosidase activity	57, 58
Methanolic extract	Anti-lipase	Reduction in turbidity of a triolein emulsion by porcine pancreatic lipase	59
Flavonoid compounds isolated from methanolic extract	Anti-HIV	Effects on C8166 human T lymphoblastoid cells infected with HIV-1MN and H9 human T-cell lymphoma cells chronically infected with HIV-1IIIB	60
Essential oil and absolute	Antimicrobial	Disk, well-diffusion, microdilution methods	55, 61-67
Essential oil	Anticonvulsant	PTZ (Pentylenetetrazol)-induced seizures in Wistar rats The amygdala electrical kindling seizures in rat	68-70
Essential oil and phenylethyl alcohol	Neuroprotective, memory enhancing	Inhibition against acetylcholine esterase (AChE)	71
Chloroform extract	Neuroprotective, treatment of dementia	Neurite outgrowth activity testing	72
Cyanidin-3-O-β-glucoside from rose buds	Cardiovascular function	ACE (Angiotensin-I-converting enzyme) inhibition	73
Fresh flower juice	Hepatoprotective	Antioxidant activity tests	74
Herbal eye drop containing *R. damascena* extract	Ophthalmic disorders	Clinical tests	75

The author is indebted for much of the proceeding section on Turkish rose water history and medicine, to Professor Dr. Ayten Altintas (1948-) Emeritus professor of the Department of Medical History and Ethics of Istanbul University Faculty of Medicine 1996-2015). Professor Dr. Ayten Altintas focused on Turkish Medical Education which led on to Ottoman medical treatments, which prompted her enthusiasm into rose water history on which she a leading authority. Together with her colleagues Hüsnü Can Baser, and Mine Kürkçüoglu, Dr. Ayten wrote her seminal work *"Turkish Rose: A Review of the History, Ethnobotany, and Modern Uses of Rose Petals, Rose Oil, Rose Water, and Other Rose Products"* in 2012, which I have used and cited enthusiastically.

5.11 Rose Oil

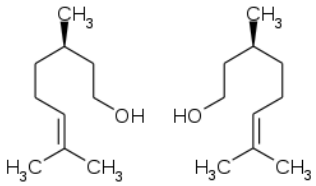
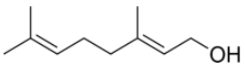
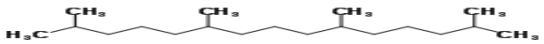
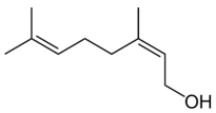
Rose oil, also known as rose otto, attar of rose, attar of roses, or rose essence, is the essential oil extracted from the petals of *Rosa x damascena*. *Rose ottos* are extracted through steam distillation, the *rose absolutes* are obtained through solvent extraction, or supercritical carbon dioxide extraction. Even with their high price, and with the advent of organic synthesis, rose oils are still the most widely used essential oil in perfumery. Rose essential oil is a product of double distillation. It is a complex mixture of thousands of components. The development of the analytical techniques and methodology, and the elucidation of its composition is becoming progressively, better known. (Base & Buchbauer 2003)[ccxxiv]

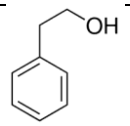
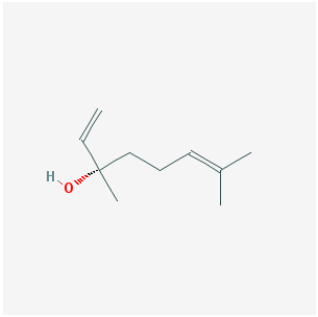
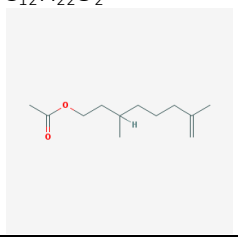
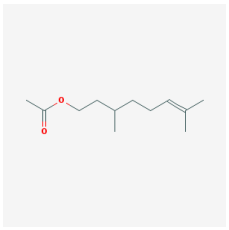
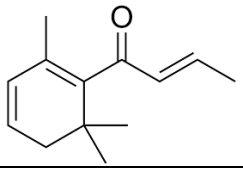
5.12 The Chemical and Olfactive Features of Rose Water and Rose Oil

A comparative study was initiated to explore whether the constituent content of various assessions of the Damask, ranging in locality from Bulgaria to Turkey, and Syria to Iran, showed similarities sufficient to identify the passage of the Damask from one area to another. That is, is it obvious that the constituent chemicals in the base of the petals from roses from different localities, even countries, shared a common origin. The basic character of rose oil is mostly dependent upon citronellol and geraniol. It is further modified by nerol (5 to 11 %) and farnesol (0.2 to 1.4 %). Higher farnesol content gives a stronger floral character. Nerol not only adds to the rosaceous character, but also to its freshness. When the geraniol content is low, freshness of nerol manifests itself as slightly citrusy. When geraniol content is high, the combination of citronellol, geraniol, farnesol, and nerol, results in a strong, sweet, floral, fresh rosaceous character. Other typical constituents of rose oil are geranyl acetate, nonanal, citronellyl formate, citronellyl acetate, eugenol, methyl eugenol, cis-rose oxide, alpha-terpineol, phenylethyl alcohol, and linalool. Damascenones and some sulphur compounds are among the minor components. Stearoptenes, the paraffins, are natural constituents of rose oil, and due to their presence, rose oil solidifies at room temperature, and when refrigerated. (Sari 2000)[ccxxv], (Baser 1992)[ccxxvi] This research investigated whether there was correlation between samples, taken from assessions growing along the path of the transmigration of the Damask from its Central Asian and Persian origins, to Rome. To further that end, the main constituents of rose oil, noted in this comparative study, are recorded in [Table 17], and are as follows:

Table 17. The main constituents of rose oil (Verma 2010) [ccxxvii]

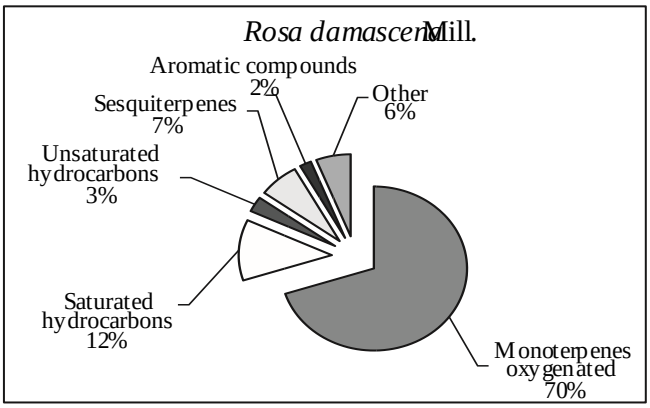
(Structures from ChemSpider, Royal Society of Chemistry. http://www.chemspider.com)

Citronellol	$C_{10}H_{20}O$ 	Citronellol, or dihydrogeraniol, is a natural acyclic monoterpenoid, which are lipids that can be found in all classes of living things, and are the largest group of natural products. About 60% of all known natural products are terpenoids. Both enantiometers occur in nature. The two stereoisomers that are mirror images of each other, but non-superposable, that is they are not identical. (+)-Citronellol, which is found in citronella oils, including *Lemon Grass* is the more common isomer. (–)-Citronellol is found in the oils of *rose* (18–55%) and *Pelargonium* geraniums. (Lawless 1992)[ccxxviii]
Geraniol	$C_{10}H_{18}O$ 	Geraniol is a monoterpenoid and an alcohol. It is the primary part of rose oil, palmarosa oil, and citronella oil. Monoterpenes are a class of terpenes that consist of two isoprene units and have the molecular formula
Nondecane	$C_{19}H_{40}$. 	Nonadecane is an alkane hydrocarbon with the chemical formula $CH_3(CH_2)_{17}CH_3$, simplified to $C_{19}H_{40}$.
Nerol	$C_{10}H_{18}O$ 	Nerol is a monoterpene found in many essential oils such as lemongrass and hops. It was originally isolated from nerol oil, hence its name.
1-nonadecane	$CH_3(CH_2)_{17}CH_3$	Simplified to $C_{19}H_{40}$., Nonadecane is an alkane hydrocarbon.
Phenyl ethyl Alcohol	$C_8H_{10}O$	Phenethyl alcohol, or 2-phenylethanol, is the organic compound that consists of a phenethyl group attached to OH.

		It is a colourless liquid that is slightly soluble in water, but miscible with most organic solvents
Linalool	$C_{10}H_{18}O$ 	Linalool is a naturally occurring terpene alcohol chemical found in many flowers and spice plants.
Rhodinyl Acetate	$C_{12}H_{22}O_2$ 	Terpene-alcohol-acetates mixture; colourless-to-yellow, combustible liquid with rose scent; soluble in mineral oil, alcohol, and glycerin.
Citronellyl Acetate	$C_{12}H_{22}O_2$ 	A colorless clear liquid
Damascenones	Beta damascenone 	Damascenones are a series of closely related chemical compounds that are components of a variety of essential oils.

The damascenones belong to a family of chemicals known as rose ketones, which also includes damascones and ionones. *beta*-Damascenone is a major contributor to the aroma of roses, despite its very low concentration, and is an important fragrance chemical used in perfumery. (Leffingwell 2016)[ccxxix] Research by Firmenich, a private Swiss company, the largest private company in the world, in the perfume business led to the discovery of the so-called Rose Ketones. The importance of the rose ketones has allowed the creation of dramatically new type perfumes for example, Dior's "Poison" (1985)], wherein damascenone and the alpha- & beta-damascones may be used at quite high levels.

The information from [Table 17.] above, re-interpreted in a pie-chart [Fig.100].



[Fig. 93]. Percentage Composition of the Components Identified through Gas Chromatography in Essential Oil of *Rosa* Extracted through Hexane Solvent Extraction (Younis 2007) [ccxxx]

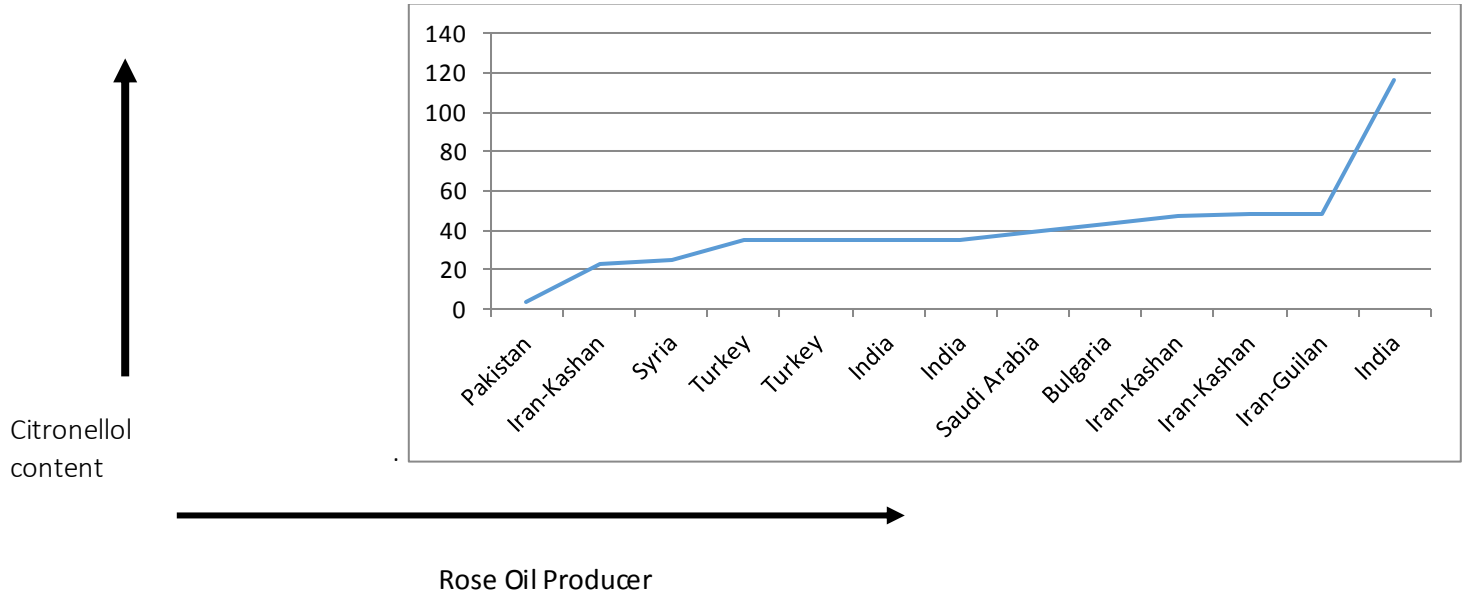
To the same end, comparisons were made of the chemical composition of the different genotypes Oil-Bearing Roses. [Table 18]

Units by percentage of volume	Citronellol	Geraniol	Nonadecane	Nerol	1-nonadecene	methyl eugenol Germacrene D	Heneicosane	rhodinol	phenylethyl alcohol	β-caryophyllene	citronellyl acetate	Linalool
Origin												
Pakistan	3.7	1.5						2.7	70.9		2.5	
Iran-Kashan	23	16	10.5-40.5				7-14					
Iran-Kashan	14.5-47.5	5.5-18	10.5-40.5				7-14					
Iran-Kashan	48.2	17							5.1	5.4		
Turkey	35.2	22.2	13.8	10.3								
India	115.9-35.3	8.3-32.	4-16	4-9.6			2.6-7.9					
Iran-Guilan		15.5		3.1	18.6							3.4
Turkey	38.7	17.2	7.2	8.3								
India	24.5-42.9	2.1-18.1	6.4-18.9	0.7-7.6	1.8-5.4	2.3-8.9						
India			10.5									
Bulgaria	23.4	19	11.9	7.5					27.2			
Saudi Arabia	23-28	14-20	11-16	6-11			7					8
Syria	26-30	28-31	4-6	12-14		6-8						1-3

[Table 18]. Chemical composition of rose essential oil from different part of Central Asia. [ccxxxi]

Regrettably, the research proved to be inconclusive, [Table 16a] save that in broad terms the further west the Damask transmigrated, the lower the Citronellol content. Whether this becomes significant in future rose breeding programmes remains to be seen.

[Table 19] Graph showing Citronellol content by country.



Culinary Uses

Tempting as it is to turn this thesis into a rose water recipe recital, suffice to say that rose water is used ubiquitously in cuisine throughout the Arab world, and, indeed beyond. Recipes for drinks, savoury and sweet dishes are to be found in the cuisines of the Moslem world and throughout Central Asia and India.

This thesis promotes but one, a life saver in the hot, dry, arid world of the Damask rose; rose water ice cream!

Ingredients

200g pistachios, plus extra for garnish

600ml milk

75g sugar

6 egg yolks

300ml double cream

1–3 tsp rose water

candied rose petals, for garnish

Read more at http://www.hairybikers.com/recipes/view/rose

Western cookery today does not make much use of roses or rose water. However, it was a popular ingredient in ancient times and continued to be popular well into the Renaissance. It was most commonly used in desserts, and still is found as a flavour in traditional desserts such as marzipan or turrón.

Fig. 94 Rose water ice cream

Method

Put the pistachios in a large frying pan and toast them very lightly for a couple of minutes. Leave the pistachios to cool, and then grind them as finely as possible in a food processor.

Put the pistachios in a saucepan with the milk and 40g of the sugar and heat until the sugar has dissolved. Allow the milk to come almost to boiling point, and then remove the pan from the heat, cover, and leave to infuse. Leave the mixture for at least an hour for a decent flavour, or overnight if you can.

Strain the milk and pistachio mixture thoroughly, then reheat, again to just below boiling point. Put the egg yolks in a bowl with the remaining sugar and whisk until the mixture is light and mousse-like. Pour the infused milk over the egg yolks, stirring to combine, then pour everything back into the saucepan. Stir over a very low heat until the mixture is the consistency of fairly thin custard. If you are worried about the mixture curdling, you can pour the mixture into a bowl and place it over a pan of simmering water, then stir.

Remove the custard from the heat and leave it to cool down. Chill thoroughly, and then pour in the double cream. Mix to combine then gradually add the rose water, tasting as you go.

Churn the mixture in an ice cream maker, then put it in the freezer for a couple of hours before serving. If you don't have an ice cream maker, freeze the mixture in a plastic box and whisk at regular intervals to get air into it. Continue until it is too hard to work. Serve garnished with candied rose petals and chopped pistachios. [Fig.94]

Chapter 6.

Roses in antiquity and the Damask rose in Classical Rome

Roses in Antiquity

The preceding chapters have set the background for this chapter, an analysis of where the Damask rose was grown in antiquity, and specifically where it was grown in Classical Rome.

The earliest historical records on Mesopotamian cuneiform tablets indicate that rose became known to humans about 5,000 years ago (Farrar 2006)[ccxxxii]. A clay tablet inscribed with a commentary about Sargon the 1st. the King of Akkadia (2684-2630 BCE), records that the king took '*rose saplings*' during his military campaign to the countries across the Tigris River (Vecera 1989)[ccxxxiii]. The author disputes Vecera's assertion, in so far that the correct translation should be "suckers", not "saplings", (4.12 p.85)). Since Sargon formerly lived in the ancient city of Ur, near Babylon, his journey was most probably to south eastern Anatolia, in present-day Turkey. (Vecera 1989)[ccxxxiv] One of the many pitfalls encountered in the search for evidence of roses in the literature of antiquity, is the use of the word 'rose' in connection with plants that have no association whatsoever, with roses. For example, the *Rose of Jericho* which is a colloquial name for *Selaginella lepidophylla*, the spike moss; as it is for, *Anastatica hierochuntica,* a Palestinian tumbleweed. Another example is the *Rose of Sharon,* a common name for Hypericum *calycinum*. This is particularly true of references to roses in the Old Testament, although notably in Ecclesiasticus 24:14; 39:13; 50: 8; Solomon 2:1., Esdras 2:19., and Isaiah 35:1 the text appears to describe the rose. Certainly, rose are indigenous to Syria, and therefore it seems likely that these references, refer to the rose, as in the genus *Rosa.* However, at the time of writing there is no published, conclusive study.

The rose and cultural traditions in antiquity

In Greek mythology, the rose is known as the flower of the goddesses. Chloris who was associated with spring, flowers and new growth, wore a crown of roses; and the rose was the symbol of Aphrodite, the goddess of love and beauty. When Aphrodite presented a rose to Eros, the god of love, the rose became the symbol of love and desire, which is why she anointed Hector's dead body with rose oil. (Altintas 2013)[ccxxxv]

The rose became the symbol of silence and secrecy when Eros gave a rose to Harpocrates, the god of silence, hence *sub rosa* "under the rose", refers to something confidential. The term was actually derived much later from medieval diplomatic meetings, during which a rose was hung as a sign of secrecy and confidentiality. (Scotland Europa 2012)[ccxxxvi]

The Greek poet Sappho (600 BCE) named the rose "the Queen of Flowers" in her poetry. (Altintas 2013)[ccxxxvii] . According to the Greek historian, Herodotus, (490-420 BCE), the Phrygian king Midas, who reigned in Central Anatolia near Eskisehir in 700 BCE, grew fragrant roses in his gardens. After his defeat by the Persian army, he took his roses to Macedonia. Those roses were believed to be *R. damascena var. semperflorens* which is still grown and referred to in some parts of Anatolia, as the "King's rose." ((Altintas 2013)[ccxxxviii].Theophrastus

(300 BCE), the Greek naturalist, wrote the botanical descriptions of a whole range of different roses, bearing from between five petals and one hundred petals. (Altintas 2013)[ccxxxix] . Herodotus wrote of 60 petalled roses. Lane Fox says that "there are many who believe these to be *R. gallica* not *R. x damascena"*. Without a description of the morphology of the whole plant it is difficult to know which Herodotus describes. However a clue may be found in that Herodotus describes roses in cultivation rather than roses growing in the wild. If that is the case Rosa *x damascena* was the favoured plant.

The Flower of Venus

The Romans were besotted with roses in their public, social and personal lives. Whether for their scent, their use in the arts, medicine, hygiene, sanitation, decoration, as gifts to their gods (Columella), [ccxl] or, albeit rarely, in their gardens, roses were ubiquitous. Flowers were of huge importance in the Roman world and with no flowers from distant countries to import and compete (Kock 1884)[ccxli] roses were at the forefront of the Roman floriculturists' world.

Sources that describe this phenomenon are numerous. In respect of floriculture in the ancient Mediterranean, Theophrastus (d. 287 BCE) extols the rose in his influential *Historia Plantarum (The History of Plants)* written between c. 310 BCE and c. 287 BCE (Theophrastus 350-287BCE)[ccxlii]. Pliny the Elder speaks of flowers and wreaths in the opening lines of his XXI book of *Naturalis Historia.*[ccxliii] Pliny the Elder drew on, among others, the works of Mnesitheus of Athens (4th. C BC) (Pliny *Naturalis Historia)*[ccxliv] ; Callimachus (311-240 BC), the great scholar and poet of Alexandria Egypt, and Apollodorus of Damascus (d.181 BC), a Syrian-Greek, from Damascus, of the 2nd century AD (Pliny, *Naturalis Historia*).[ccxlv].

Roses in Classical Rome

[Fig. 95]. The Painted Garden of the Villa of Livia, Prima Porta. Painted c. 30-20 BC,

Fig.96. Detail from [Fig 95] Note the number of petals indicating the form of the Damask, as opposed to R. *gallica,* or *R. centifolia.*

The frescoes of Livia's villa at Prima Porta, Rome, [Figs. 95 & 96] are the most famous representations of Roman gardens. (Caneva & Bohuny 2002)[ccxlvi] analysed the botany of the painted flora and critically discussed previous identifications. Their analysis is frankly open to doubt in so far that they identify the roses in the villa

as *Rosa centifolia*. They cite Coggiatti (Coggiatti 1986)[ccxlvii] as their source who says, "diagnostic elements, the habit of the plant, the general morphology of the flowers, five petals brightly red coloured, along with some considerations of historical character (Coggiatti 1986)[ccxlviii] , lead to the exclusion of a *Damask rose* as proposed by Gabriel (Gabriel 1955)[ccxlix]". Manifestly Coggiatti is incorrect. The rose depicted is clearly and lightly double and hence a hybrid not a species. R. gallica is never very double and only very rarely lightly double. Realistically, the only lightly double candidate, at the time, was the Damask; and, he confuses the single *Rosa gallica* with the heavily double *Rosa centifolia* [Fig. 42]

The Roses of Paestum

The most beautiful of the roses grown in the region of Italy in the vicinity of Rome, and indeed, in the classical world, were the roses of Paestum.(Mello 2003)[ccl] Paestum was, historically, a major ancient Greek port, on the coast of the Tyrrhenian Sea in Magna Graecia in southern Italy. [Map 13]

[Map 13]. Location of Paestum, south of Naples, Italy.

Following its foundation by Greek colonists under the name of Poseidonia, the Greek being Ποσειδωνία, the port was eventually conquered by the local Lucanians and later, by the Romans . The Lucanians renamed it, Paistos, and the Romans later gave the city its current name. (Cancik et al. 2013)[ccli]. As a centre for rose growing it was abandoned in the early part of the first century BCE, not only because the growers lacked artificial heating, but also because this marshy region became ridden with malaria. The growers dispersed to the Roman colonies, consequently the rose of *Paestum* was not necessarily the only rose celebrated in Latin literature as *pestane, because* the name was also given to those *pestane* roses grown by the colonials. However, by the end of the second part of the first century the region had become brackish Loperte et al 2011)[cclii], and the effects of malaria, and the effects of the war against Hannibal, (247 –181 BC) had subsided. (Mellow 2003)[ccliii] Rose growing around Paestum was back in fashion. Pliny however, makes not a mention of

the Rose of Paestum which is curious considering his dedication to detail of all things horticultural; and furthermore because over the same period, both Columella in De re Rustica (X, 35 ff.) [ccliv] and Martial (Epigrams VI, 80) [cclv] describe this nub of Roman rose growing, in poetic detail. Pliny was however, a man of the world, he knew the area of Campania particularly well, and held allegiances to the region. Paestum sits a little further to the south, and was major competition to the region of Campania, which was also noted for the prowess of its rose nurseries during the Golden Age. (Aratus, *Phaenomena* 1XII)[cclvi] The ground was well drained compared to Paestum and was suitably fertile for rose growing which enabled the plants to produce more scent than their Paestum counterparts. What is more, they flowered over an extended season compared with the once flowering rose species, and they flowered early. (*plus apud Campanos ointments quant apud ceteros olei proud* (Pliny *Naturalis Historia* XVIII, 111).[cclvii]. (*Campania east, Milesia evening novissima tamen Praenestina*) (Pliny *Naturalis Historia* XXI, 20).[cclviii]. The result, the roses from the Campania region just north of Naples, particularly from Capua Preneste became far better known than the roses of Paestum. It appears that considerable efforts were made to guard the details of the methods of cultivation of the two regions. (Mello 2003) Not least that the late flowering Damask *Rosa x damascena* was grown in Campania (Pliny *Naturalis Historia* X XI 17).[cclix] rather than the form we now know as *Rosa centifolia* that was grown in Paestum at the time. This trade secret evidently became widely known in so far that *Rosa centifolia* was displaced by the far more productive, *Rosa x damascena*. (Mello 2003)[cclx]. There is firm literary evidence for the manufacture of rose water, and also that the fame of the roses of Paestum was widespread in the second half of the first century BCE. (Ellis 2012)[cclxi] The remontancy substantiated allegedly by Virgil in his oft quoted phrase, *Nerem biferique rosaria Paesti*, (Virgil Georgics, IV, 119)[cclxii]. Is based on a mistranslation.

"Atque equidem, extremo ni iam sub fine laborum
vela traham et terris festinem advertere proram
forsitan et, pinguis hortos quae cura colendi
ornaret, canerem biferique rosaria Paesti
quoque modo potis gauderent intiba rivis
et virides apio ripae, tortusque per herbam
cresceret in ventram cucumis . . ."

This, from Virgil's *Georgics* (IV:116-122), has been taken to refer to reblooming roses in Paestum Italy in the Augustan age of Rome. However, the pertinent section literally translates as "the rose-gardens of twice-bearing Paestum."

And I myself, were I not even now Furling my sails, and, nigh the journey's end, Eager to turn my vessels row to shore, Perchance would sing what careful husbandry Makes the trim garden smile; of Paestum too, the rose beds of twice bearing Paestum;; [cclxiii]

Double- or constant-bearing was something of a poetical commonplace for expressions concerning 'bounteous Nature' in classical times. Homer remarks on the continuous bearing through the year of pears, apples, figs, grapes, and olives in the garden of Alcinous in the *Odyssey* (VII:117 ff.); Hesiod, in *Works and Days* (lines 172-173) refers to three-times-a-year bearing in the Blessed Isles, for the benefit of defunct heroes. Less poetically, in a classical *Florus* 1:11:3, we see a reference to Campania, where Paestum is situated; it tells us that Campania "bis floribus vernat" which translates as "Campania twice springs with flowers" or "*everything* is repeat-blooming in Campania"! Ovid (*Metamorphoses* XV: 708) puts it succinctly:

"On towards Leucosia and Paestum's headland,
Where roses love the warmth."

It would appear that the supposed reblooming roses were simply vigorous plants blooming over an extended season much as the same as many other plants in Paestum and Campania due to the favourable climate. Maybe the "twice-bearing Paestum" and the "twice-blooming Campania" are literary conventions similar to the expressions "thrice beautiful" or "doubly accursed", namely intensifiers, not a statement to be taken literally. Maybe this, and the complete absence of any definitive written word puts paid to the claim for truly remontant roses in Paestum.

However, as this thesis has described above (pp. 36-40) remontancy is not so cut and dried as was once thought. The commentators on Virgil's *biferique rosaria Paesti* were writing prior to recent biochemical research. Advances post DNA analysis in evolutionary genetics and taxonomy, together with recent research that has identified the remontant gene and how it operates, has painted a less than black and white picture of which roses and when roses are remontant, and the extent to which roses are remontant. Climatic change, particularly increases in temperature has accentuated the issue. There are degrees of remontancy that vary with the vagaries of habitat and climate, and with the number of shoots that are genetically disposed to flowering repeatedly, and thus the number of flowers produced. Roses once thought of as once flowering now display remontancy. The roses of Paestum can no longer be classified as remontant or not. Extended flowering periods might now be described as remontancy and twice flowering roses may not be the only remontant roses. The definition of remontancy has changed and broadened. It would be imprudent to write off remontancy of the *Roses of Paestum* until the genetics involved in remontancy of both *R. x damascena* and *R. centifolia* are fully researched. To confuse the issue Propertius, advises (IV:v:61) that

"Sweet Paestum's rose, for life and beauty born
May wither in the sultry breath of morn."

The rose to which he refers does not exhibit the florist's demand for a long shelf life.

It seems that in the interests of entrepreneurial diplomacy, Pliny was silently, protecting the trade secrets of Campanian growers, rather than favouring the nurserymen of Paestum. We do not know when and for sure even if the Greeks brought the art of rose growing to Paestum, and there is little concrete evidence of exactly how and when the first nurseries were established. (Kock)[cclxiv]. However, there is archaeological evidence of perfume shops dating back to 273 BCE (Brun 1999)[cclxv] Also, evidence from the production of *unguentaria*, small ceramic or glass bottles, found frequently by archaeologists at Hellenistic and Roman sites, which were commonly used as containers for rose for oil (Brun 1999)[cclxvi].

The characteristics of the roses of Paestum

The Paestum roses were bright pink, almost reddish; they were intensely fragrant, and they flowered over a long season. This was something new to the Romans. Never before had they encountered roses that flowered longer over a longer period than the few weeks of the rose species.

Ovid suggests that roses flowered twice due to the warm climate, and Martial, (Epigrams VI, 80). [cclxvii] quoting Vergil[cclxviii] says that the roses even flowered during the winter, (Epigrams X, 31, 1 ff.) [cclxix] and likewise, in Egypt. *(Martial)*[cclxx] The only other plant that flowered repeatedly, and was used in daily commerce was the violet.

Roman perfumers and perfume

An essential part of the supply chain were the perfumers, the retailers of rose water. An interesting aspect of Paestum floriculture, and also the economic history of the city, were the apparatus used for the extraction of essences and for the production of perfumes. In particular, the presses used to extract the valuable juice from the petals, and the vats for seeping the roots of the rose to make the cheap by product *rhodinum*. *Rhodinum* was used as a substitute for pressings from the rose petals to make a cheaper but inferior product. The cost of production of pure rose water was very high, because of the enormous quantity of the raw material, the flowers, which were required to make the best perfumes. Consequently, the growers resorted to pressing other parts of the plant, for *rhodinum* from the roots in particular, with which to adulterate the juice from the rose petals. (p.97) Overtly, or not, they used any process to get the product by the cheapest means possible to the suburban areas. (Mello 2003)[cclxxi]. To have the job done professionally and expeditiously, the entrepreneurial perfumers relied on a pool of highly capable, freelancing, skilled workers. J. P. Brun's seminal work, *Roman Perfume Boutiques*, published in 1998[cclxxii] , both confirms, and describes, how the businesses worked, using evidence from archaeological research conducted in the 'north-west corner of the *forum* in Paestum. There, ever since the founding of the Greek colony, an area was reserved for perfumer's shops. Interestingly, these shops are similar to those found in archaeological digs on Delos, a Greek Cycladean island, close to Mykonos. The perfumers of Paestum, who clearly enjoyed the best vantage points for their shops, were similar to those discovered in Pompeii and Capua. In fact, the collection centre for the Capuan product was actually in the centre of a nearby town called Seplasia. The brand 'Seplasian' denoted high quality. There was not just one firm, but many producers called 'ungentarii' and 'thurarii'. Their

names are well documented. (Forbes 1955). Since there was no guild of 'unguent' makers, most of the 'ungentarii' were managed by a few larger producers, who owned efficient organisations for the collection and despatch of not only of their own product, but the product from the smaller producers. It would seem that the Capuan trade, (Forbes 1955)[cclxxiii] bought raw product from Paestum, and also from Praeneste and Capua itself. Foreign spices, when required to add different aromas to the product, were bought from Vespasian's Spice Market, the centre of the trade in Rome. Even though other towns produced rose water, Capua appears to have outshone them and captured the export trade. Late in the Empire, adulteration of the product became rampant. Pliny has much to say on the subject. (Forbes 1955). Demetrius, a commercial magnate who tried to corner the market, was accused by the townsmen of Seplasia of using white drops of resin from the 'stone pine', *Pinus pinea*, instead of the very expensive ingredient, frankincense. Seplasia's reputation was demolished, and Capua's fraudulent policy cost the town its western Mediterranean competitive trade, which was happily taken on by the city of Alexandria in Egypt. (Forbes 1955). Archeologically important, are the excavated remains of the renowned perfumeries on the island of Delos. Hellenistic-period perfumeries have been identified by finds of equipment used for pressing oil; storage jars, furnaces for heating, and basins for *'steeping* 'the petals in oil. (Brun, 2000). [cclxxiv]. The area around Corinth was also associated with perfume production. Archaeologically significant, are the finds of the small ceramic *aryballoi* for containing oil, which were shipped all around the Mediterranean. During archaeological excavations, a portrayal of the rose water manufacturing process was discovered in a fresco from the House of Vettii, Pompeii (pre.79CE). Cupids are involved in extracting oil from a wedge press, [Fig.97] and are also shown adding rose petals to a steeping basin, while nearby a lady samples the fragrances. (Mattingly, 1990)[cclxxv].

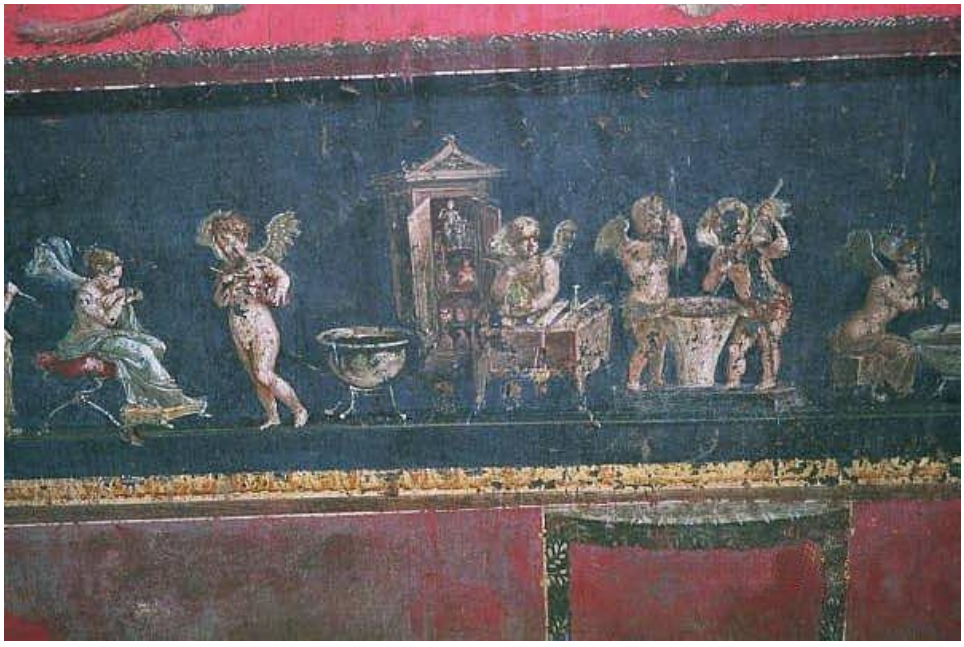


Fig. 97 A section of a long frieze depicting cupids at work. House of Vettii, Pompeii 62 CE. http://clagnut.com/sandbox/dynamic-layout/

Jashemski's work at Pompeii has identified commercial gardens within the city, the most likely locations for the production of flowers for the perfume industry. Inscriptions have been found in the town that name two of the *unguentarii*, M. Decidius Fastus and Phoebus (Jashemski, 1979)[cclxxvi]. Flowers in Campania were also used to make garlands, essential to deck out animals for sacrifice, as well as for wearing at festivals and *convivia*, the dining parties of Roman elite. Evidence for garlands is primarily textual and iconographic, again in Pompeian wall paintings, but also in sculpture. (Mattingly, 1990)[cclxxvii].

Significant to the transmigration hypothesis, proposed in this thesis, is that the method of perfume manufacture described in Paestum, and illustrated in Pompeii, was used over a millennium earlier during the Bronze Age. Clay tablets, inscribed with *Linear B Script*, from the Mycenaean-era palace at Pylos, refer to the supply of product for the manufacture of scented oils. The name of the manufacturer was this case, Thyestes, the *'ungentarus'*, the 'unguent boiler', the perfume maker. Deliveries of olive oil and other scented ingredients, such as coriander and sage, were recorded, and it seems likely that the perfume was made in courtyards on the north east of the palace (Shelmerdine, 1985). The *Linear B script* also refers to henna, *Lawsonia inermis*, being used to colour the perfume, a practice of which Theophrastus was aware. *Historia Plantarum (The History of Plants* VI, 31*)* BCE[cclxxviii]. In the Late Bronze Age, scented oils were traded all around the Mediterranean, in ceramic stirrup jars. Traces of oil of iris, but not of rose as yet, have been identified through 'residue analysis' in *aryballoi* dating from c.2000 BC, at Chamalevri on the island of Crete (Tzedakis and Martlew, 2002). (Day 2013)[cclxxix]

Roman rose water trade.

Rose petals, and cut flower are fragile and have a very limited 'shelf life'. Consequently, the rose growers of Paestum and Capua had to transport their product, their high quality cut flowers, as quickly as was possible to their customers in the large urban centres, particularly Rome. Given the long sea faring tradition along the Italian coast, traffic by sea in fast boats was the obvious and preferred choice. The supply chain model was solid; grower – transport to the port by horse drawn cart- dockers- sailing boat- port-dockers-transport- and lastly the retailer, the perfumer. Martial talks at length on how this system operated. (Martial, Epigrams X, 31)[cclxxx]

With the propensity of the Romans to indulge in luxury, the rose growing industry flourished which became a problem in itself. The Romans over-indulged. So much so, that their salacious indulgencies began to take an effect on the Roman ideal of life, to the extent that Lucius Julius Caesar (135-87 BCE) and P. Licinius Crassus (87-53 BCE) judged it necessary to put a stop to the sale of 'exotic perfumes' (*edixisse it quis venderet unguenta exotica; sic enim appellavere*) in an attempt to quell the excesses of dissolute fashion. (Mello 2003)[cclxxxi].

"The business model worked efficiently until the decline of the Roman Empire when demand diminished, and when once again, (Martial, Epigrams. VI, 80, 6: X, 60, 1: X, 26, 3) [cclxxxii] the growing fields degraded into malarial marshes. Any production that remained was sold as expensive flowers for weddings to the wealthy

classes". References to production and trade, ceased until the 5th. Century, (Mello 2003)[cclxxxiii] when Ennodius (474-521), the bishop of Pavia, 35 kilometres south of Milan, refers to *pestane* roses growing in two locations in the sixth century. He likened these roses to the roses of Paestum, citing the colour and their remontancy, and their cultivation, to those described by (Columnella)[cclxxxiv]. In the Middle Ages, Walahfrid Strabo (808-49), an Alemannic Benedictine monk, inspired by Columnella, refers to the roses of Paestum being used for their healing properties. (Mello 2003)[cclxxxv]

Apart from these few references the plant was lost until early Middle Ages, when it was generally acknowledged to have been reintroduced into Europe from Syria by the Crusaders, hence the name *damascena*. Research for this thesis has revealed nothing to substantiate what can only be considered a myth, a view supported by Jennifer Potter in her book, *The Rose*. (Potter 2010)[cclxxxvi]

Whilst Romans appreciated the rose and used it in their meetings, feasts, and parties because of its exquisite fragrance, early Christians repudiated rose as a pagan symbol.

Apocryphal, as the story of Heliogabalus's parties may be, the subject of this painting [Fig.3. p.13] admirably illustrates the connection between roses in classical Rome, and the Romans' penchant for debauchery and dissolution. In summary, the cultivation of roses at Paestum was neglected for several centuries after the fall of Rome. During this period, the only people with the leisure and sensibility to grow roses were monks and nuns, but even then, during a time of Christian antipathy towards roses and Roman tradition (Joret, 1892)[cclxxxvii]. Christian writers condemned the roles played by the rose. (Coates 1970)[cclxxxviii] For them the rose was in disfavour because of its connection with Venus, and only gradually did it make its reappearance in Christian iconography. Clement of Alexandra (150-211/14) an extremist writing as a moralist, forbade the ceremonial use of crowns of flowers, especially singling out roses and lilies; (Coates 1970)[cclxxxix] whilst Pridentious (348 -405) the influential Spanish poet praised Eulalia for despising of roses.

"Hic mihi rosae spolia
Nullus aromate frgrat odor"
Trans.
"Here no plunder of the rose
No scent of spice smells my nostrils"

The rose suffered a partial eclipse in Spain, again because in Rome it had become symbolic of a life of voluptuousness, and debauchery. The severe asceticism of some early Christians, notably the Greek, St. Clement of Alexandria (150-215 CE), caused the use of all flowers and perfumes to be denounced as abhorrent. The Greeks considered roses and lilies, special culprits (Gordon, 1953). Theirs was a natural reaction to the significance of roses to their near neighbours, and mortal enemies, the Romans. To the Greeks of the second and third centuries CE, roses, and rose water, were a major sign of Roman luxury, and indispensable on occasions of conspicuous consumption. Not only were there whole fountains of rose water, and not only would the floors sometimes be carpeted knee-deep with rose petals, but guests at banquets

would have rose petals thrown over them. At a banquet given by Nero this rain of rose petals reached such proportions that allegedly several of the noble guests suffocated under the mass of flowers (Kriissmann, 1977). Could be this be an erroneous source for the story depicted Alma-Tadema's painting of Heliogabalus's rose party. [Fig. 3.p.13]

Was the Paestum Rose the Damask rose, *Rosa x damascena*?

Conclusive identification is impossible without DNA testing. To that end, McCurdy [ccxc] has recently reviewed the literature and archaeology, but to date, no remains have been found to analyse. Consequently, it is the morphological descriptions by the Roman and Greek authors quoted earlier, who describe the plant in such detail, that the identification of the Paestum Rose as a synonym for *Rosa x damascena* is valid. Descriptions of, remontancy, colour, fragrance and size and shape of the shrub, tally with the plants growing in the field today. (Kock)[ccxci] (Hurst 1941)[ccxcii].

Damasks are not the only source of rose oil as has been explained above [p.24] However, growers are businessman. They will only grow the most productive hybrids, varieties or forms available. Rose water and being such a valuable commodity the growers of Paestum, with their international connections, would have searched far and wide for the most productive rose. That rose is today, as it was then, the Damask.

Remontancy is an issue. Learned debate over the translation of Vergil's "*biferique rosaria Paesti biferique*" are interesting but not necessarily helpful in light of recent work on remontancy. Climatic change, particularly increases in temperature has induced remontancy into roses that were once, once flowering.

Once flowering roses are easy to identify taxonomically, they flower on a stem and do not flower again. Rose bushes that flower repeatedly, or recurrently, or continuously may flower on the same stem from new shoots, or may flower on new shoots per se. It is the growth inhibitor TF1's homologue RFK described in [3.15 p.36] that determines whether the plant will flower again. This gene has been shown to be heavily influenced by heat, water, nutrient and day length (Iawata, Remay)[ccxciii]. Accordingly, there is no reason why *Rosa x damascena* should not exhibit different remontant characteristics depending on where it is grown.

Phylogenetics has advanced significantly post DNA analysis. Rose family trees have recently been compiled that reliably define which roses are related to which. Naturally occurring hybrids are now more easily recognised, whilst cladistic values and what is a form, a variety or a hybrid are more easily determined. Texts of antiquity that describe morphological detail that varies from one location and era to the next can hardly be definitive. Therefore the most compelling evidence for the identification comes from a study of the historic cultivation of the Damask for rose water production, and the historic manufacturing process compared with those still practised today, and described in the preceding chapter.

Chapter 7.

Rosa x damascena 'On the move'.

The connections between the Silk Road, the transmigration of *R. x damascena,* and the use of rose water.

Cultural Linkage facilitated the transmigration of *Rosa x damascena* from Central Asia to Rome

Having revealed an approximation of the geographical origin of the Damask, and that the Damask was used in the production of rose water, it rests now to investigate, how the plant transmigrated from the Amu Darya watershed to Rome. Research revealed that is unlikely, if not impossible, for the rose to have travelled naturally. The research has also shown that the plant travelled with the spread of the production of rose water, and that it is possible to transport, and keep *suckers* from which the rose is propagated, alive in a hot and arid terrain [p.85]. Road transport appears the obvious answer, perhaps carried in back packs, or on hand carts, or by horse and cart. The options? The roads had already been constricted by 3000 BCE. Firstly, by the Assyrians, who by 2-3,000 BCE, had set up secure trading routes, as recent research published in 2015, has evidenced. (Kulakoğlu & Öztürk 2015) [ccxciv] They found a large deposit of old Assyrian cuneiform tablets, some 23,000 in number, near Kayseri, in central Turkey, and the location of the capital city of the ancient kingdom of Kanesh. This site has shed light not only on the history of Anatolia, but also on the history of the entire Near East in antiquity. [Map 12].

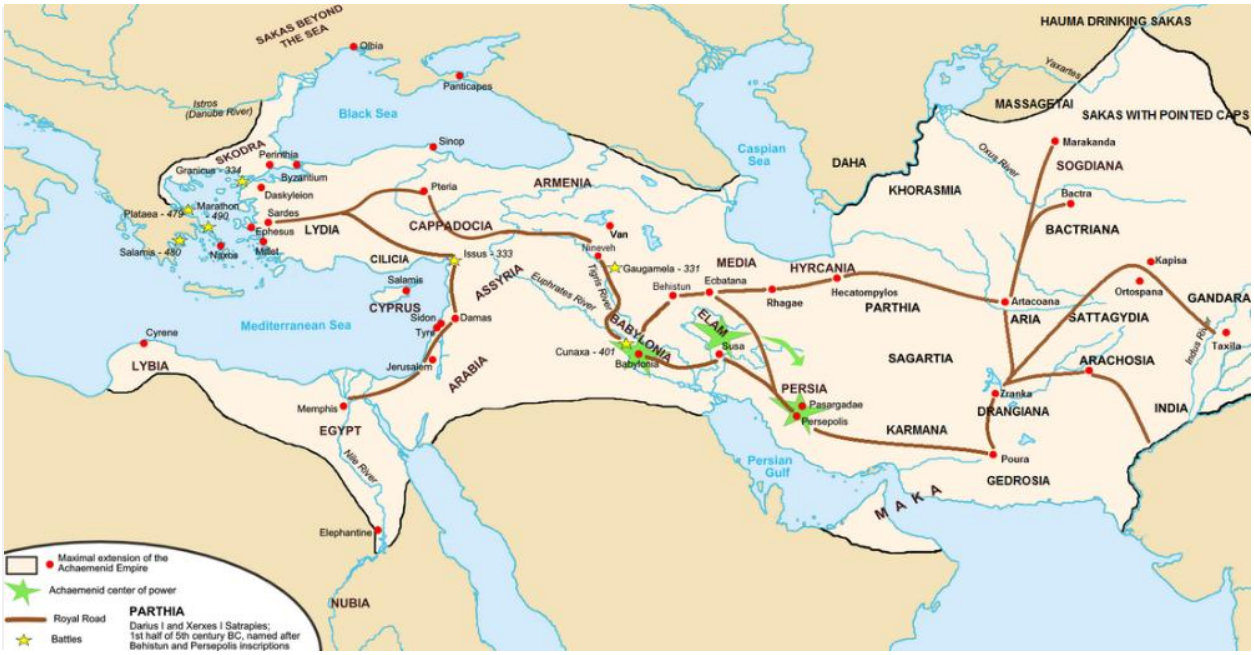
[Map 14]. The map of Assyrian trading routes and major cities 2-30000 BCE (after Kulakolu & Kangal 2010

Next, the Persian Royal Road 500-300 BCE, established during the Achaemenid Empire, (500-330 BCE) would eventually become a main artery of what became known in the 19th. Century as The Silk Road. The Royal Road, which would have taken the rose from Samarkand, directly to Rome, ran from Susa, in north Persia,

modern day Iran, to the Mediterranean Sea in Asia Minor. The road featured postal stations along the route, equipped with fresh horses for envoys to quickly deliver messages throughout the Persian Empire. Herodotus, (Histories, 8.98)[ccxcv], writing of the speed and efficiency of the Persian messengers, stated (Histories, 8.98)[ccxcvi]:

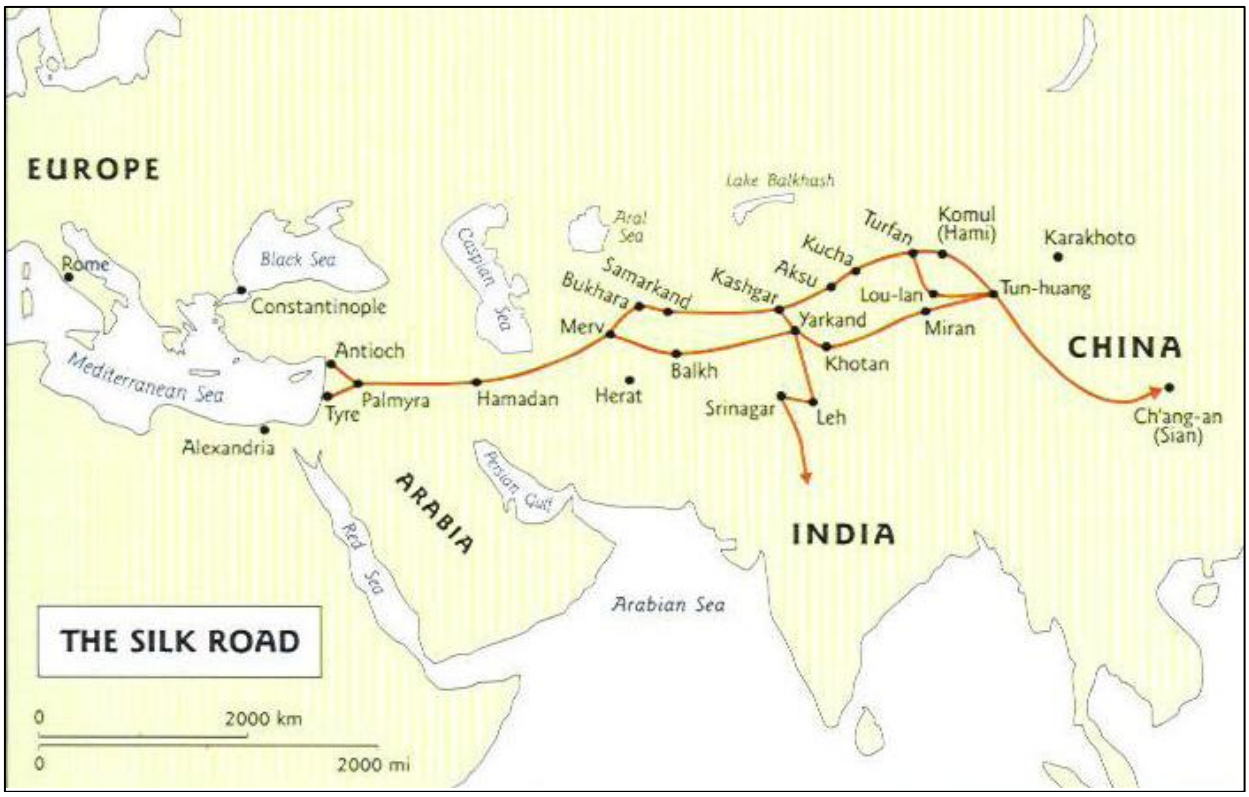
"There is nothing in the world that travels faster than these Persian couriers. Neither snow, nor rain, nor heat, nor darkness of night prevents these couriers from completing their designated stages with utmost speed."

The Persians maintained the Royal Road carefully, and expanded it through smaller side roads. These paths eventually crossed down into India, across Mesopotamia, and over into Egypt. [Map 15]



[Map 15]. Persian Royal Road 500-330 BCE The Persian Royal Road http://www.ancient.eu/

Lastly, The Silk Road 130 – 1453 CE, discussed in detail on (Page 136). [Map 16],



[Map 16]. The Silk Road. From Dru C. Gladney, 'Central Asia and China: Transnationalisation, Islamization, and Ethnicisation' in The Oxford History of Islam, ed. ed. John Esposito (New York: Oxford University Press, 1999), 441.

It is not possible to date when the Damask originated using botanical or biochemical analysis, because such analysis does not carry a date of origin. However, as opposed to most other roses grown horticulturally, *Rosa x damascena* was grown as a main stream commercial crop. In fact, the Damask is the only Central Asian rose grown in any volume, for the production of rose water. Writers and scholars from 5,000 BCE in antiquity wrote detailed, dated commentaries on the rose water production process. Preceding Chapters have surveyed the extensive volume of literature that details who produced rose water and why. [pp.63-65] Essentially the literature describes which people used rose water in their religious ceremonies, for their sanitation, their health and their hygiene; and who used rose water to fragrance a malodorous society, and also who used roses for ornament. The impact of religious ceremony on rose water usage is explored in depth [pp. 137] and the political effect of Islamic expansionism on the spread of rose water usage is the subject of future work. The research resulting from investigation into where, and when along the trade routes, rose water production was established, has been built into a timeline. The time line has then been transposed on to maps in order to evidence the route the rose took, and by what dates. The plots evidence that the Damask extended its range along the Silk Road, and the Royal Persian Road, and kept spreading West between 3500 BCE and 1400 CE.

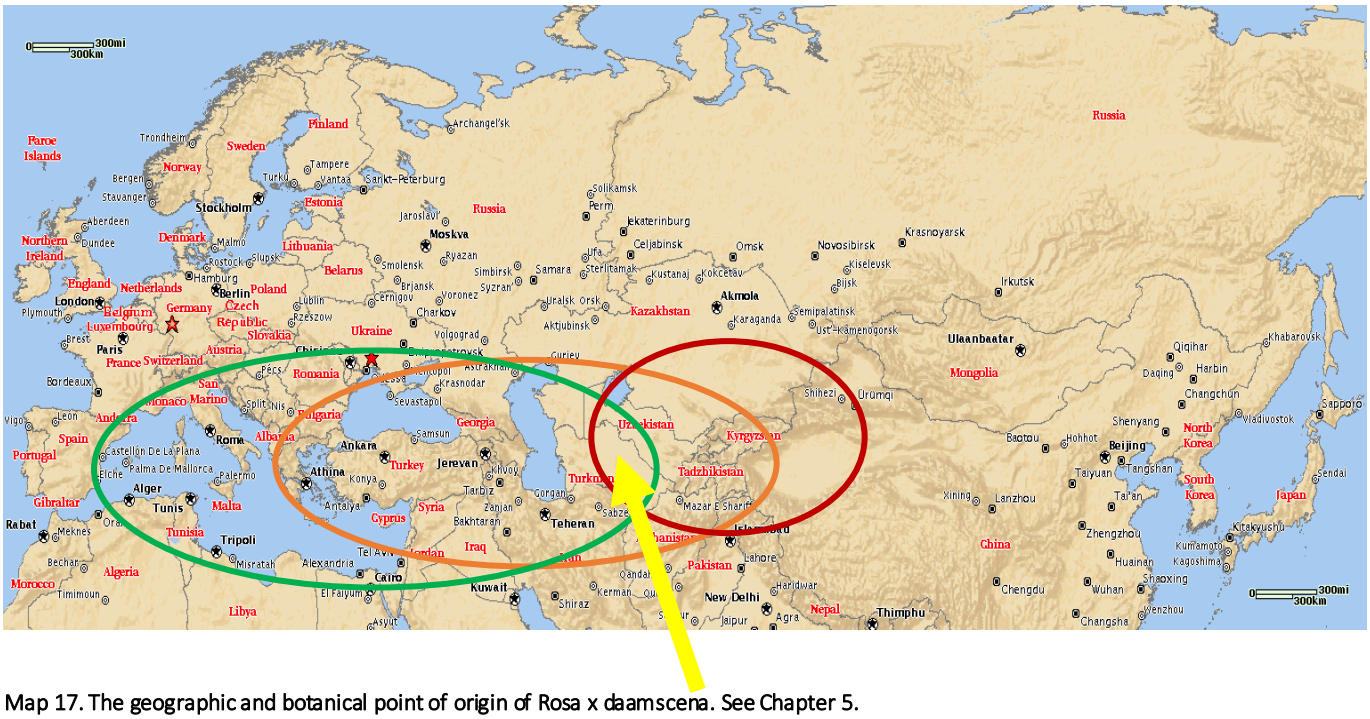
Plotting a time-line of cultural linkage.

The table below lists references in the text in terms of the date written, the writer, the location and the cultural period in which the writer lived, or referred to; annotated with numerical references detailed in the references. Geographical references have been plotted on a map, over the two principal travel routes that existed at the time.

[Table 20] Transmigration of Rosa x damascena. Time line and cultural linkage.

Date	Culture	Location	Author	Reference
AD 1523	Islam	Alexandria, Egypt	Clement	ccxii
AD 1503	Roman Catholic	Rome	Bronzino	iv
AD 1500	Orthodox	Knossos, Crete	p.144	xx
AD 1405	Timurid, Islam	Samarkand	Tamerlane p95.	
AD 1340	Orthodox	Mardin, S. Turkey	Battuta	cxlv
AD 1340	Timurid, Islam	Anatolia	Rumi	cxlv
AD 1309	Islam	Erdine	Brun	cxlvii
AD 1256	Shia, Islam	Syria	Al-Dimashq	cxli
AD 1207	Sunni, Islam	Persia		
AD 1197	Islam	Malaga, Spain	Al-Baitar	clii
AD 1120	Tengrism	Samaxi, Azerbaijan	p.119	cliii
AD 1055	Islam Ghaznavid	Qamsar	Malekshah	clxxi
AD 1005	Islam	Kashgar	Kashgari	cxl
AD 1000	Islam	Baghdad	Fars	cxxxxviii
AD 980	Islam	Bukhara, Uzbekistan	Avicenna	cli
AD 800	Islam	Baghdad	Al-Kindi	cxlviii
AD 800	Islam	Morocco	See Case Study p.131	xli
AD 632	Islam	Saudi Arabia	Muhammed	clxvi
AD 474	Roman, Pagan	Pavia, Italy	Ennodius	ccvii
AD 455	Vandal	Carthage	Dracontius	cllxxxvi
AD 348	Roman, Pagan	Spain	Pridentious	ccxii
AD 310	Roman/Vandal	Bordeaux, France	Ausonius	cllxxxvi
AD 181	Roman, Pagan	Damascus Syria	Apollodorus	clxxxviii
AD 203	Roman, Pagan	Rome	Heliogabalus	v
AD 70	Roman, Pagan	Cadiz, Spain	Columnella	clxxxv
AD 50	Roman, Pagan	Rome	Pliny *Naturalis Historia*	[ccxcvii].
AD 43	Dacian Roman	Romania	Ovid	cllxxxvi

AD 41	Roman, Pagan	Egypt	Martialis	cxcviii
AD 41	Roman, Pagan	Egypt	Martialis	cxcviii
AD 41	Roman, Pagan	Rome	Martialis	cllxxxvi
AD 40	Byzantine	South East Turkey, Syria	Dioscorides	clxxvii
AD 4	Roman, Pagan	Syria	p.119	cxxi
BCE 4	Macedonian	Athens, Greece	Mnesitheus	clxxxviii
BCE 8	Seleucid	Ionic Syrian	Homer	clxxvii
BCE 58	Roman, Pagan	Rome	Livia	cxc
BCE 247	Roman, Pagan	Paestum	Hannibal	cxciii
BCE 300	Ptolemaic	Athens, Lesbos	Theophrastus	clxxviii
BCE 311	Ptolemaic	Egypt	Callimachus	clxxxviii
BCE 454	Macedonian	Bulgaria	Aetius	cxxxvi
BCE 460	Archaic Period	Greece	Hippocrates	cxxxv
BCE 480	Achaemenid	Delos	p.150	ccii
BCE 480	Bacchiad	Corinth	p.150	cciii
BCE 490	Persian	Macedonia	Midas	clxxvii
BCE 600	Persian	Lesbos Greece	Sappho	clxxvi
BCE 900	Hellenistic	Ios, Greece	Homer	
BCE 1200	Akkadian	Sumeria	p.119	cxvii
BCE 1200	Mitanni	Assyria	p.119	cxvii
BCE 1500	Gandhara	India	Zoroaster	clxxxi
BCE 1500	Phoenician	Syria	Zoroaster	clxxxi
BCE 1500	Armenian	Egypt	Zoroaster	clxxxi
BCE 1600	Hyksos dynasty	Egypt	Thutmose	cxxviii
BCE 1600	Minoan	Crete	p.119	cxxvii
BCE 1750	Hittite	Anatolia, Turkey	p.119	cxxvi
BCE 2000	Minoan	Crete	P150	cciv
BCE 2500	Sumerian	Iran	Houtumn-Schindler	clxxi
BCE 2600	Harappan	Punjab	p.119	cxvi
BCE 2684	Sumerian	Ur, near Babylon	Sargon	clxxii
BCE 3000	Harappan	Taxilia, Afghanistan	Hearth	clxxiii
BCE 3500	Sumerian	Mesopotamia	p.119	cxvii
BCE 3500	Semitic Nr. East	Assyria	p.143	clxxiii
BCE 5000	Harappan	Indus Valley	p.119	cxv

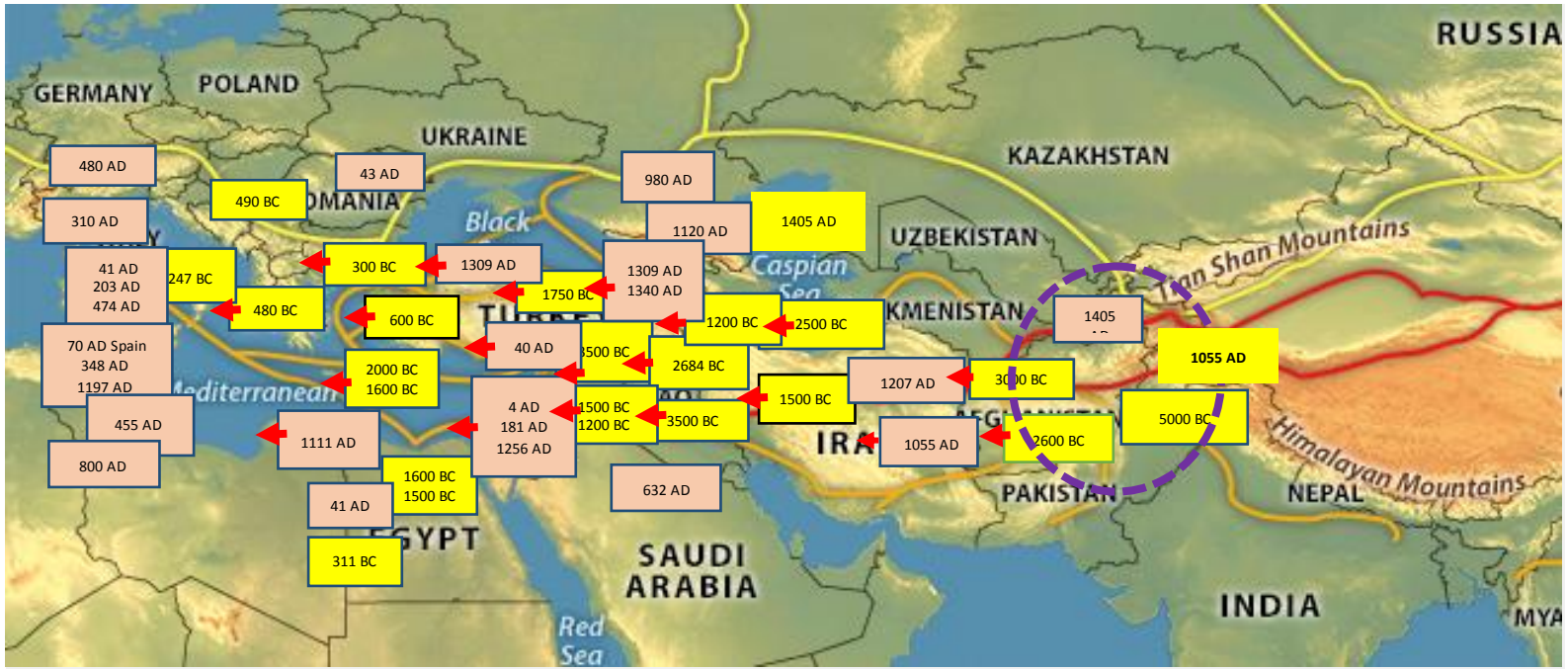


Map 17. The geographic and botanical point of origin of Rosa x daamscena. See Chapter 5.

Superimposition of the dated references from Table 23, over the route of the Silk Road, and over the point of origin of *Rosa x damascena*

Layers of information from: [Map 9 p. 58]; the trading routes of the Assyrians 2-3,000 BCE [map 14]; plus, the route of the Persian Royal Road 500-330 BCE [Map 15.] the references complete with their dates included in the timeline [Table 20.] have been plotted on the map of principle routes of The Silk Road. [Map 16] to produce [Map 18].

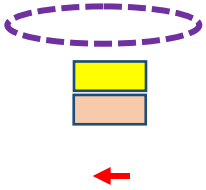
This map graphically illustrates the transmigration, the passage of *Rosa x damascena* from its Central Asian origin to Rome along the Silk Road from 3000 to 300 BCE.



[Map 18]. *Rosa x damascena*, geographical point of origin and direction and dates of transmigration, from the watershed of the river Amu Darya in Uzbekistan to Classical Rome

Key:

1. Hypothetical geographical point of origin of Rosa x damascena.
2. Plots by date and location selected from Table of references to *Rosa x damascena* and rose water BCE.
3. Plots by date and location selected from Table of references to *Rosa x damascena* and rose water AD.
4. Note that *Rosa x damascena* carrying its remontant gene both the requisite for the production of rose water. progresses steadily west from c.3000 BC through to c. 1300AD west from the Oxus Valley along the route of the Persian Royal Road, a main artery of The Silk Road, until it arrived in Rome



"The Silk Road, A New History"

"Purity of the mind is considered just as important in the Islamic world, as an unsullied physique". *(Quran 2:222)*[ccxcviii] Chapter 5.10, examined the pharmacology associated with rose water, and its influence on physical complaints. The following essay explores the influence of rose water on the religions, more specifically, the belief systems, of Central Asia and the Middle East, in an attempt to discover whether it was the nurture of the spirit, or the body, that encouraged the transmigration of the Damask rose.

The Silk Road conjures up an image of caravans of camels, laden with silk on a dusty precipitous desert track, reaching from China to Rome. However, Valerie Hansen, of Harvard University, in her extensive and scholarly researched, recently published "*The Silk Road, A New History*" has questioned the long held notion of the straight and well-travelled road to China, or come to that, to Rome. (Hansen 2012)[ccxcix] Hansen found key records that had remained hidden, often for safe keeping, in the sands of the Taklimakan Desert and in the seven oases located along the route, from Xi'an to Samarkand. In the oases towns merchants, envoys, pilgrims, religious refugees and travellers all mixed in cosmopolitan communities, tolerant of each other's religious beliefs. These ranged from Buddhism to Christianity, and Zoroastrianism to Manichaeism, that is until the arrival of Islamic conversion.

There was no single continuous road but rather a chain of market towns that traded within a radius of 80 kilometres that ran between East and Central Asia. China's principle trading partner was Persia; there was no direct trade with Rome. Silk was not the most important trade on the route, rather it was paper, metals, spice and glass and silk. But, it was, Hansen found, the dissemination of ideas, technologies and artistic motifs, which were by far and away the most important transmission. Never the less as Schafer says in his 'The Golden Peaches of Samarkand' there were goods, in this case exotic peaches that made their way from Samarkand to China in the T'ang dynasty (Schafer 1985).[ccc]

However, for this research, it is the religious refugees and their Islamic aggressors described by Hansen, who are the most important Silk Road inhabitants. "These converts brought their religions and languages to their new homes. Buddhism originating in India and enjoying genuine popularity in China, had the most influence, but Manichaeism, Zoroastrianism and the Eastern Christian Church based in Syria, all had strong followings. The people living along the Silk Road played a crucial role in transmitting, translating and modifying these belief systems as they passed from one civilisation to another" (Hansen 2012)[ccci]. Until the arrival of Islam these different communities were surprisingly tolerant of each other's beliefs. Islam put a different inference on social relationships. There was interaction for the first time, and the hitherto inalienable right to worship the God of your choice was under threat. The Islamic aggressors were intolerant of others beliefs, believing that the one true path was through conversion to Islam, and adopting Islamic teaching and doctrinal rites. Although Hansen did not recognise it, one common denominator of these religions, is their use of rosewater as an integral, essential, feature of their ceremonies and its use in health, sanitation and fragrancing. It was not difficult for the Islamic aggressors to insist on the continuing, copious, use of rose water in their converts'

religious services and customs, in medicine and in the kitchen. Crucial to this thesis, Hansen describes the waves of religious refugees, fleeing north and then east and west from the Muslims. Valerie Hansen has been very helpful in pointing the author in the direction of potential evidence to support the theory that the aforementioned refugees were subjected to religious conversion to Islam, and that this conversion to Islam included the production of rose water, so as to sustain the Islamic doctrine.
The Damask rose growers would have followed the Islamic converts, presumably selecting their most productive remontant hybrids, to plant as they resettled to satiate demand from the converts or from the refugees as they resettled.

The religions of the 'Old World' of 1500 BCE to 1400 CE, which were connected to overland trade in Asia. Asian and Mediterranean religions followed a similar pattern of growth and dissemination, from west to east and from east to west along the Silk Road. Rose water was used in the religious ceremonies of the Buddhist faith, (Chuang 2006) [ccciii] the Hindus (Hindu Universe 2016)[ccciii], the Zoroastrians (Eduljee 2015)[ccciv]. Rose water is used to clean the Kaaba, the Qibla for Muslims located in Mecca, (Al-Zahrani 2016)[cccv] where water from the Zamzam Well is combined with rose water as an additive. In the Indian subcontinent and Southeast Asia during Muslim burials, rose water is often sprinkled in the dug grave, before placing the body inside. (*Teachings of Islam*, Talim-ul-Haq 2016)[cccvi]. Rose water also figures in Christianity, particularly in the Eastern Orthodox Church (Alkiviadis 1992)[cccvii], and in the Baha'i Faith, the Most Holy Book (Kitab-i-Aqdas 1:76) orders believers to make use of rose water. (Baha'u'llah 1992)[cccviii] As new religious communities were established throughout Asia, their continued existence was ensured, largely, by support from the merchants. Consequently, the relationship of religious traditions to traders, including the use of rose water, was one of dependence such that arguably, and historically speaking, the whole idea of world religion is inextricably connected to long-distance commercial activity. (Foltz 2000)[cccix] The Silk Road runs along the southern edge of the central Eurasian steppe, where the dry flatlands, meet the mountains, and where snow melt streams provide a secure water supply. Human migrants settled within this ecological transition zone between 3000 BCE and 200 CE, eventually establishing oasis towns where travellers would rest, resupply, and trade. The Persians of the steppe played a substantial role in transporting gold, silver, and wool to China. There also appears to have been a return trade; a silk fragment from China was discovered in an Egyptian tomb dating from about 1000 BCE. (Lubec 1993)[cccx] The ancient Israelites, ancestors of the Jews, also may have traded along the Silk Road. It is certain that by 722 BCE, Israelites lived in the eastern Iranian world, because their Assyrian conquerors transplanted them there. (Foltz 2000)[cccxi].
In ancient times, religions did not practice missionary work. Religious traditions were viewed typically as specific, cultural attributes, not as universal truths to be adopted by all peoples. For example, the religions of the Iranians and the Israelites spread quite widely throughout the ancient world, but peoples with whom the Iranians and Israelites traded would have perceived their religious influence at best as intriguing foreign

ideas, rather than as an ultimate spiritual truth upon which salvation depended. The benefits of a particular religious approach were considered the inalienable property of the culture possessing it. When the Persian king Cyrus (530 BCE), liberated the Jews from Babylonian captivity in 559 BCE, many Jews chose to take up residence within the Persian Empire. At the same time, these people remained in contact with other Hebraic groups from Babylonia as far as to Egypt, through trade. Those living in the Iranian world conveyed various aspects of Persian culture to those living elsewhere, and in this way many Persian religious ideas were absorbed into Judaism, and later into Christianity, Manichaeism, and Islam. Among these were an eschatological view of time and the belief in a messianic saviour, a bodily resurrection and a last judgement, a heavenly paradise and a hell for sinners, and a supernatural force responsible for evil.

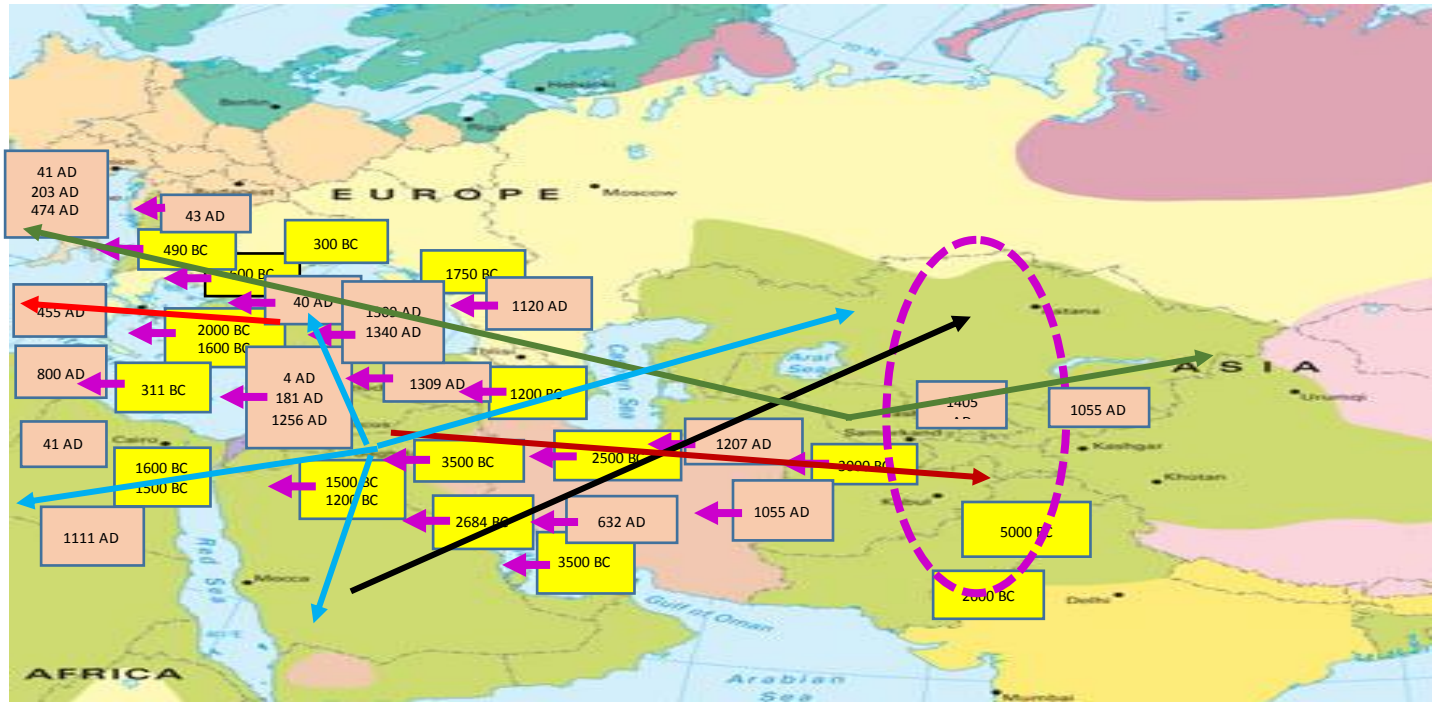
The first Christians were Jews, who spread Christianity through Jewish trade networks based in Babylonia. The Virgin Mary was dubbed "the thornless rose," and, to some extent, pagan legends about Aphrodite and her rose began to be attributed to Mary. (Vecera 1989)[cccxii] During the first centuries of the Christian era, doctrinal disputes increasingly led eastern Christians to assert their independence from the leadership of Mediterranean Christianity. By the late 5th century CE, the Eastern Church, with its seat at the Persian capital of Ctesiphon in Mesopotamia, broke from the Church of Rome. A synod of eastern bishops in 497 CE declared Nestorianism, a theology that stated the human and divine natures in Jesus Christ were distinct, to be their official doctrine. It was this Nestorian form of Christianity that Persian and Sogdian merchants transmitted eastward along the Silk Road. By the middle of the 600s Nestorian bishoprics were found in Samarkand, in central Uzbekistan; and Kashgar, in the present day, Xinjiang Uygur Autonomous Region of China. Along the Persian Royal Road, the main artery of the Silk Road, miracle-working Persian Nestorian priests, whom the Turks perceived as especially powerful shamans, baptised large tribes of Turkic nomads.

During the early 3rd century CE another universal, missionary religion, Manichaeism, emerged from the mixed Semitic-Persian cultural zone of Mesopotamia. Its prophet, Mani, was born of Parthian parents into a Jewish-Christian Baptist sect, but he travelled to India in his early 20s, and in addition absorbed various influences there. His religion drew from Semitic, Persian, and Indian traditions, combined with a belief in Gnosticism, the salvation through secret knowledge. It postulated a radically dualistic universe in which good and evil were locked in constant struggle. Along with certain Buddhist concepts such as reincarnation, Mani adopted Buddhism's four-part social structure, divided between male and female monks and laity. Within a hundred years his teachings attained widespread popularity throughout the Mediterranean and Persian worlds, posing a severe threat to competing religious visions. His main rival at the Sassanid court was Kartir, the chief priest of the Persian monotheistic religion, Zoroastrianism. The rose appears in the ancient Zoroastrian religious book, Avesta, written in Persia during the 9th century CE, as one of the symbols of immortal angels. It was believed that the beautiful fragrance extracted from the flowers had mystical powers and played an important role in the worship of the god of light, Ahura Mazda. (Vecera 1989)[cccxiii] . Despite the persecution of devotees throughout both the Roman and Sassanid empires, Manichaeism continued to

spread and win converts. In the east, Sogdian merchants, yet again, played the major role in transmitting the religion along what is now known as the Silk Road, via their communities of traders. A major Manichaean centre took root in the Sogdian capital of Samarkand, beyond the military reach of the Sassanids. The Sogdians returned with the Uygurs, to their capital north of the Tien Shan, and eventually converted the king to their faith. Under the king's sponsorship Manichaeism became the state religion of the Uygur Empire until 840 CE, and for several centuries afterward it retained many Turkish adherents including the use of rose water. The spread of the religions described above are plotted on [Map 19]. In early 600 CE Islam appeared in western Arabia. Rose water takes a fundamental role in Islamic religious ceremony. Arab conquests followed international trade routes, and as a result Islamic law increasingly ruled international trade. By 711 CE the Arabs had conquered Transoxiana, in southeast Central Asia, and Sogdian merchants again saw the advantages of belonging to a culture with wide-ranging commercial contacts. With the fall of the Mongol Yuan dynasty in 1368 CE, the period of peace that had so favoured trans-Asian trade, came to an end. With their connections to cultural centres in the west broken, Zoroastrianism, Judaism, Manichaeism, and Christianity faded from the scene in Central and Eastern Asia. (Foltz 2000)[cccxiv]. Starr describes these transmigrations with greater insight. (Starr 2015) Starr F. Lost Enlightenment: Central Asia's Golden Age from the Arab Conquest to Tamerlane Princeton 2015

The Silk Road has left spiritual beliefs that are now known as "world religions," faiths that were founded in the caravans of east-west trade, and over time and land spread throughout the world. [Map 19. P.140]

[Map 19]. Transmigration of *R. x damascena* and the production of rose water superimposed on the Belief Systems or Faith Systems of the region.



Key to Belief Systems

- Lamaistic Buddhism
- Theravada Buddhism
- Shinto Buddhism
- Confucianism Taoism Buddhism
- Hinduism
- Tribal & Traditional
- Sunni Islam
- Shia Islam
- Eastern Orthodox
- Protestantism
- Roman Catholic
- Judaism

Direction of transmigration of *R. x damascena* and rose water across different regions of belief from 3000BC to 1200 AD.

Spread of Zoroastrianism (1200 BCE to 700 CE)

Spread of Manichaeism (216 – 1400 CE)

Spread of Nestorianism. (385 – 635 CE)

Spread of Christianity (1 CE -)

Spread of Islam (700 CE -)

Chapter 8.

Discussion

Introduction

So as to allow preceding sections to read fluidly, the evidence for, and the arguments against the proposals put forward, have been integrated within the respective chapter. There is nothing to be gained by repeating this debate. However, there are a few of points of contention, which require further debate.

Remontancy in the wild was not thought to show over lapping distributions

Remontancy in the wild was not thought to show overlapping distributions in Central Asia and Europe. [3.16 p.39] This is not so much a question of previous authors being wrong per se, but more that those authors were ill informed. Either, they did not fully investigate distributions recorded in the relevant Floras, or, that new information has only recently come to light. In particular, the revised distribution of *Rosa fedtschenkoana* which is highlighted on [pp. 59-63]; and, the new research that shows remontancy in several more Central Asian Rose Species. [p.40; Appendix 3]. It appears that remontancy is not a black and white phenomenon, but rather a question of how much a rose exhibits the ability to flower recurrently, and under what conditions.

Caveat, validity and precision in plotting plant distributions.

The definition of the measure of accuracy, in plotting the geographical botanical distributions rose species, has been explained in [Chapter 4.9 p.81]. This is the measure of accuracy required by this thesis, to evidence the overlap of the distributions of, *Rosa x damascena* Mill, *Rosa moschata* Herm. and *Rosa fedtschenkoana*. The evidence has been built by 'linking the dots', that is, linking up and plotting the recorded locations, of the species concerned on maps. The thesis does not pretend that the distributions are complete, there are still locations of the plants which have yet to be recorded, or, are not as yet published.

Rosa x damascena in Mattock's Oxford Rose Nurseries (Botanical artist Olgaberi 1960)

Rose Water.

Perhaps under emphasised, in [Chapter 4.9 p.73] is that merely plotting the point of origin of *Rosa x damascena* despite in itself, being a new contribution to botany and history, was insufficient to evidence the hypothesis that cultural linkage facilitated the transmigration of the remontant gene in *Rosa x damascena*, the Damask rose, in circa 3,500 BCE, from the river Amu Darya watershed in Central Asia, to Rome by 300 BCE. Botanical records of plant locations, do not illustrate why a plant extends its geographical range. It was, therefore somewhat of a break through to discover, from reading Classic texts, the ubiquitous use of rose water, throughout Central Asia and the Middle East in antiquity. Plotting references to the use of rose water described in the texts, established a time line, and the routes by which the Damask extended its range, and furthermore, the reason why it transmigrated; the cultural linkage of the hypothesis.

The Roses of Paestum.

No fossilised, or archaeological 'finds' of the Damask have been discovered in Rome, consequently Paleoethnobotanic archaeology has been of no assistance, in providing DNA for identifying whether the Rose of Paestum, the *pestane* rose of the Classics was, in actual fact *Rosa x damascena.* In the absence of DNA, evidence has instead, been based on comparisons of the detailed descriptions of the *pestane* rose both in the literature and in frescoes, and with the botany, *and the ecological and cultural information, available for comparison with modern plants. Pliny compares R x damascena* and *R. centifolia* without the hindsight of phylogenetics and evolutionary genetics to assist him in determining the phylogeny. The evidence that the *pestane* rose of the Classics was *Rosa x damascena* is compelling and will become more so after the study on the evolutionary genetics and taxonomy of its parents is complete. [Chapter 6. p.96-102].

Meanwhile, research into *R x damascena* and the fragrance in its flowers, moves on at some pace. Why? The vast rose water and rose oil industry, is so lucrative in Iran, that the search for means of increasing production is of huge concern, and well-funded. For example, a study has found different genotypes of *R. x damascena* in the Kashan, Kerman and Tabriz regions, whilst looking at the Iranian production of Damask Roses (Haghighi 2009)[xcccxv] The question currently being posed, in their quest for increasing rose oil production, is *R. x damascena* a species, or is it a complex of cultivars? (Haghighi 2009)[cccxvi] Is the plant currently known as *R. x damascena,* just the plant that Miller found first, and that he named as the 'type'? An analogous situation occurs in respect of *R. moschata* Herrm. In this case, Herrm describes the specimen first known to him, as the '*type*'. However, there are a whole range of morphologically similar, 'musk-type' roses, including *R. moschata, R. ruscinonensis, R. abyssinica, R. freitagii, R. godefroyne, R. brunonii,* and *R.*

sambucina. Their phylogeny is only just beginning to be determined, [see Appendix 1 Case Study 2] and work published in by Fougère *et al* (Fougère et al 2015)[cccxvii].

In summary, there is an element of ill-founded doubt over whether *Rosa fedtschenkoana* is the pollen parent of *R x damascena.* However, in support of this thesis, whatever the parent that Iawata *et al* found, turns out to be taxonomically, it will be a Central Asian rose species and at a biochemical, molecular level, one of the parents of *R. x damascena*.

Remontancy in rose species present in Central Asia in addition to *Rosa fedtschenkoana.*

To clarify the situation conclusively, the project, the subject of [Case Study 2] based at the University of Bath, aspires to clarify the phylogeny of this largely un-researched group of roses. (see Appendix 1). Meanwhile, because they are mentioned in Ciragan's argument the following are detailed in Appendix 3. *Rosa beggeriana, Rosa brunonii, R. webbiana.*

Chapter 9

Conclusion

The thesis exhibits conclusive evidence that cultural linkage facilitated the transmigration of the remontant gene in *Rosa x damascena*, the Damask rose, a species not indigenous to Europe, from the river Amu Darya watershed in Central Asia, in circa 3,500 BCE, to Rome by 300 BCE,

The multidisciplinary research towards proving this hypothesis comes from both the humanities and the sciences. The conclusion was reached by synthesising evidence from both disciplines. Archaeological specimens of plant material from *Rosa x damascena* have not been discovered, and are not therefore available for identification by scientific analysis. Conversely the remontant *Rosa x damascena* was identified in Roman paintings and frescoes in classical villas in Rome, which provoked the question, why? Remontancy was thought to have arrived in Europe far later, in the 16th. and 18th. centuries. A literature review of the classics revealed references to these repeat flowering, remontant roses. Theophrastus is particularly helpful, because he describes the roses he saw growing, from a professional grower's perspective. He records the number of petals, the fragrance and the colour of the flowers as well as the nature of the growth. Pliny is more specific in that he helpfully compares the species we now know as *Rosa centifolia* with *Rosa x damascena* which he knew *as* the pestane rose, or the rose of Paestum. The painting of the rose in 'The Painted Garden of the Villa of Livia, Prima Porta' painted in c. 30-20 BC and the painting depicting rose water production in Pompeii 62 CE., support the descriptions of the rose in the literature. The identification of the Damask as the remontant rose growing in Rome about 300BC came from comparing these descriptions with named specimens of *Rosa x damascena,* growing in Europe today. Quite clearly the remontant rose in the Rome of antiquity, was the Damask.

A clue to the rose's origin came from the work of three Japanese biochemists who discovered the parentage of *Rosa x damascena* to be *Rosa gallica*, *Rosa moschata* Herrm and *Rosa fedtschenkoana*. Their research was held in doubt, not least because whilst the geographical distributions of *Rosa gallica* and *Rosa moschata* Herrm were known to overlap, it was thought that the geographical distribution of *Rosa fedtschenkoana* did not. Research in the *Floras* of Central Asia, and in the medicinal herbals of Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan, revealed that the distribution of *Rosa fedtschenkoana* lay far *further* to the west than originally thought. The distribution was found to overlap with those of *Rosa gallica* and *Rosa moschata.* Plotting the revised overlap evidences that *Rosa x damascena* was a naturally occurring hybrid, and pinpointed, for the first time, that its point of origin lies within the River Amu Darya watershed.

The hot arid harsh climate of Central Asia predicates against the long distance travel and survival of most forms of plant material used in the propagation and the cultivation of the Damask except for 'suckers'. Detailed descriptions in the classics prove to be misleading because 19th. and 20th. Century translators of both the original, and the secondary sources, used the words for cuttings, saplings and grafts applied to the

propagation of vines, propagating material which would not have survived the desiccation induced by the climate of Central Asia. They did not translate the propagation of roses with a word for a sucker. Suckers wrapped in a wet blanket, can survive for weeks. Never the less the descriptions of rose propagation in the classics are supported by research undertaken during a recent field trip, which established which methods of propagation and cultivation of the Damask, are used in present day Morocco, under similar climatic conditions to those of central Asia. The research showed that the methods of horticultural production and cultivation used in Morocco today mirror those of Central Asia in antiquity.

The evidence for transmigration comes from an analysis of the current locations of the use of the Damask for the production of rose water, plus the detailed descriptions in the classics, of the large white bases of the petals from the Damask rose, being used in the manufacture of rose water. A new perspective, because in the west roses are considered to be garden plants rather than a commercial horticultural crop. That the Damask was used in the production of rose water on a grand scale, and that this production was so widespread, was something not described in western literature. The classics record where and when rose water production took place. Dates for rose water production were established, either from references in the texts, or by using the date of birth and death of the writer, then plotted on a time line, and subsequently, overlaid on a map of the established roads of the classical era. The roads are now known as *The Silk Road,* and its principal artery, the *Royal Persian Road*. The superimposition of the dated, classical references to the production of rose water, on to historic maps of the Silk Road, show that two correlate over the entire distance from Samarkand to Rome.

The use of rose water and the cultivation of the Damask spread in tandem, because of the increasing demand of civilisation for the product in health, hygiene, sanitation, medicine, and fragrancing.

The classics revealed that the Damask had been used in Rome and Greece for the production of rose water from 300 BCE and that rose water was in use from 3500 BCE in Central Asia. A comparative study seeking to establish whether production methods were unique to any one region showed that the method of production is ubiquitous, and has not changed significantly, since 2500 BCE.

Research into the early spread of faiths and beliefs across Central Asia did not substantiate a correlation with the spread of the production of rose water. Surprisingly, because the early faiths, Zoroastrianism, Manichaeism, Judaism and Orthodox Christianity all used rose water. It appears that the inalienable right to practice one's religion seems to have had little effect of the production and use of rose water, and the direction in which the rose transmigrated. The cultural linkage involving the education of different, but geographically nearby races, in corporeal cleanliness, medicine, sanitation and cuisine, appears to have taken precedent over religious fervour. That is until Islamic aggressors started to enforce their doctrines on their neighbours. As a result, the Damask ceased to transmigrate peacefully. A lesson the warring nations of the Middle East, might do well to learn again.

This thesis fills a significant gap in the knowledge of how the Damask rose played a pivotal role in the history of the rose, and presents a new perception, a new history, of how repeat flowering, large flowered, strongly fragrant garden roses arrived in the West.

Table of research findings	*Unpublished, research by Mattock # Sourced from other's research
The rose carrying that carried the remontant gene to Rome by 300 BCE was *Rosa x damascena*, the Damask Rose.	#
The geographical distribution of the rose species, *Rosa gallica, Rosa moschata* Herrm and *Rosa fedtschenkoana,* the parents of *Rosa x damascena,* overlap.	*
The point of origin of *Rosa x damascena* has been derived from the overlap which when plotted on a map shows the location to be the river Amu Darya watershed, in Central Asia.	*
Rose water, rosaceum and rose oil is produced from the petals of *the* Damask.	#
The connection between the Damask and rose water production in antiquity was established from reading descriptions of the production in the Classics. Notably, those written by Columnella, Dioscorides, Pliny and Theophrastus and Virgil.	*
The cultivation of the Damask for rose water production is described in detail in the Classics. However, Latin and Greek translations of the original sources have misleadingly confused the word for 'sucker', the term for the material used to propagate the Damask, with the words for saplings, cuttings, reeds, screws and twigs. The latter would have perished in the climate of the Silk Road, and consequently the Damask would not have transmigrated.	*
The use of rose water and the cultivation of the Damask spread in tandem, because of the demand for the product in health, hygiene, sanitation, medicine, and fragrancing.	*
Rose water production spread west along the routes used by merchants and religious refugees, namely The Silk Road and the Royal Persian Road.	*
Dates and locations for the transmigration of the Damask, derived from Classical texts, have been plotted on to a time line and onto a map. The map evidences and illustrates the passage of the Damask from Central Asia to Rome.	*
Cultural linkage enabled the geographic spread of the manufacture of rose water, and in consequence the transmigration of the remontant gene in the Damask along the Silk Road to Rome.	*
Rose water manufacture was stopped by the Roman Christians circa 350 CE, and recommenced with Islamic expansionism from circa 800 C.	#
The thesis examines whether beliefs and faith were the driving force behind the cultural linkage, and concludes that the use of rose water in health, hygiene and medicine transcended religious fervour. Map plotted.	*
The thesis fills a significant gap in the knowledge of how the Damask rose played such a pivotal role in the history of the rose.	*
Lastly, the thesis proposes a new perception, a new history, of how repeat flowering, large flowered, strongly fragrant garden roses arrived in the West.	*

Summary

In summary, the thesis shows for the first time, how horticulturally, and botanically, remontancy arrived in Classical Rome in the genome of the Damask, *Rosa x damascena*. This has been demonstrated, by a map illustrating the point of origin of the Damask rose, a 'time line' and a map describing when the rose extended its range along the Silk Road to Rome, and finally a map evidencing that transmigration of the Damask along the Silk Road was incentivised by the demand for improved health, sanitation, medicine and for a fragrant society rather than religious subservience. In conclusion, it was not an enthusiasm for a gardening novelty, but rather cultural linkage in the use of rose water, that incentivised the transmigration of the Damask from Central Asia to Classical Rome. The result, a new perception, a new history, of how repeat flowering, large flowered, strongly fragrant garden roses arrived in the West.

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[Fig. 98] *Rosa x damascena* var. Ispahan.
Growing in the Robert Mattock Roses Nurseries, near Oxford 2003

The Syrian Damask Rose Restoration Project.

Syria and the potential for a practical, humanitarian application of the research for this thesis.

'The Silk Road Hybrids' (Mattock 2017) showed that Syria played a pivotal role in the transmigration of *Rosa x damascena* and rose water production from the watershed of the Amu Darya in Uzbekistan to Rome by 400BCE. Syria served as the interface of the traditions of rose water production of the Persian Empire and those of the Roman Empire. Consequently the Syrian use of rose water and the rose water production process was well documented since the days of Theophrastus in the third century BCE. 'The Silk Road Hybrids' demonstrated that regardless of which faith held sway in the Levant rose water linked different peoples, because it improved health, hygiene, sanitation, medicine, and the fragrancing of daily life.

Regrettably and recently, this cultural linkage has come to an abrupt, and abhorrent, stop. The current civil war in Syria has resulted in the decimation of the rose fields used for producing the *Rosa x damascena,* the Damask rose.
"Withered by war" stated the French Agence Presse in May 2016: "Syria's Damask rose is under threat."
Abu Bilal, 52, [Fig.99] owned a distillery in Ain Tarma in the Eastern Ghouta area near Damascus, where he made rose oil. His production plant is now a rebel stronghold. The war closed him down in 2011. The tradition of picking the crop has also faded, as entire families have fled the fighting between regime forces and rebel groups. "For farmers and traders, the Damask rose is a symbol of a people's agony in a country racked by a conflict, which has killed more than 400,000 people, and created millions of refugees". "Douma used to smell of roses", he said, of the besieged main town in Eastern Ghouta. "Now it reeks of gunpowder". Mr. Bilal now works at a perfumery, in a souq in the Old Town of Damascus. Only two, of the eight distilleries, are currently operational in the souq.
According to merchants in the souq, "It takes three tonnes of dried rose petals, to make a kilogram of Syrian essential oil". "Insufficient dried petals are being produced. The result, is that today there are barely 250 grams of oil available to buy in the whole market." Abu Bilal goes on to say, that while most of the world's Damask rose crop, which he thinks, is grown in Iran, Bulgaria and Turkey, the original oil, he insists, from Damascus is unique. "It's smell is headier, its quality is better, and it produces more oil." The pharmaceutical

and cosmetics companies, and our customers in the Gulf, like to buy our oil, it was the original oil and as such buying the best is a source of pride to them."

In short, the situation in Syria, awful as it is, presents an opportunity for introducing a humanitarian project into war torn country.

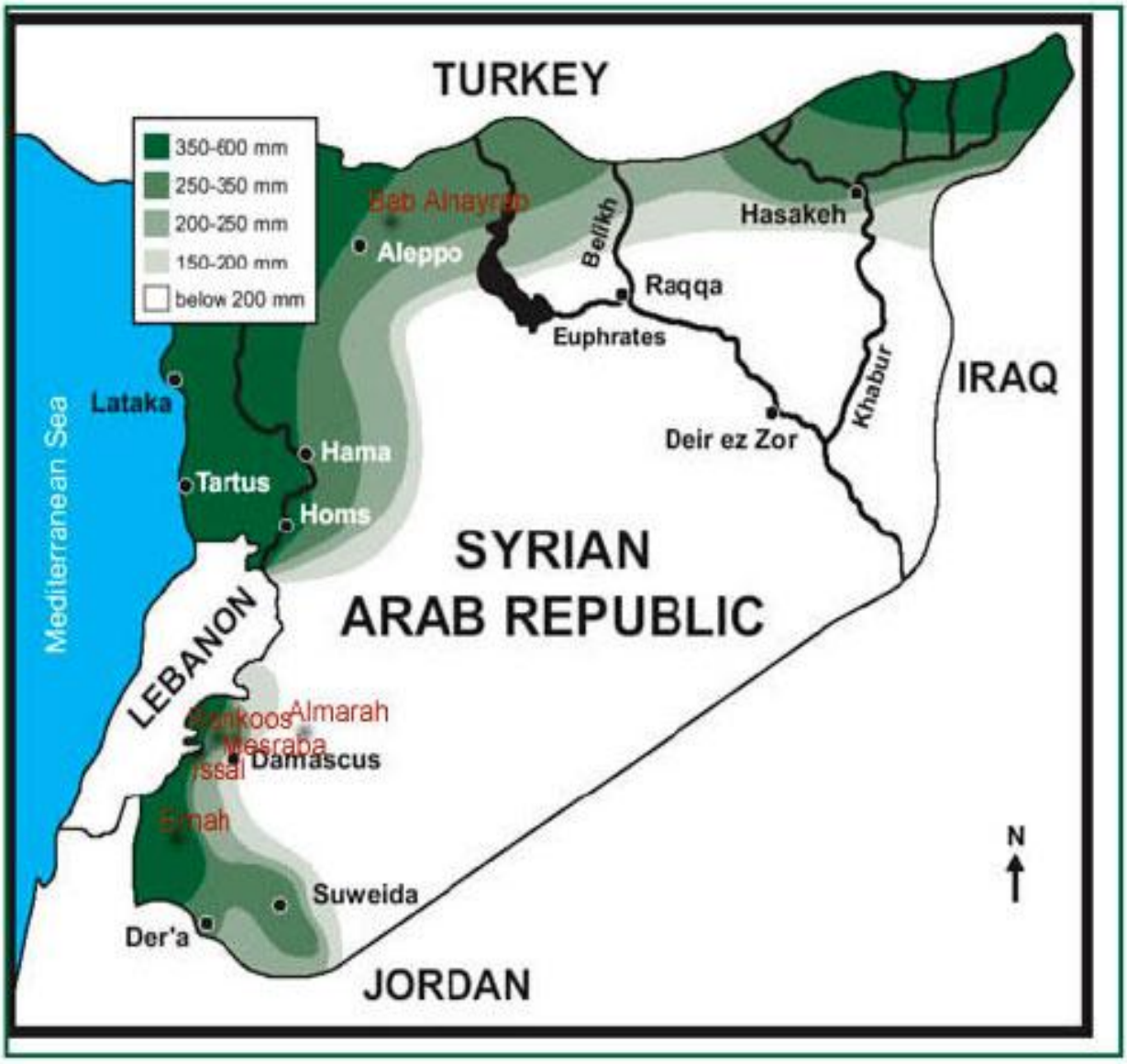
This is not to say that research and practical projects aimed at bettering the production of *Rosa x damascena* and the lot of the Syrian rose growers has not been undertaken already. Still open to conjecture is why the Syrian form of *R. x damascena,* the Syrian Damask, produces the best rose oil. In 2000 (Iwata *et al* 2000) [cccxviii] three Japanese biochemists, discovered that the parents of the Damask are (*R. gallica x R. moschata) and (R. fedschenkoana*). Mattock in his 'Silk Road Hybrids' (2017) validates Iwata *et al's* work by plotting the overlapping distributions and thus ascertaining the point of origin of *R. x damascena.* Always in the background, however, were historic reports that both *R. phoenicia* and *R. abyssinica* were parents of *Rosa. x damascena* in The Levant and in particular, Syria. Could it be that one or other or both of these Levantine rose species introduced the quality that makes Syrian rose oil so fine? This project seeks to establish if that is so. Research from Damascus University has identified the oils present in various assessions of the Syrian Damask but has not searched for additional parents.

Two leading Syrian research projects both from Damascus University, state that that *Rosa phoenicia* is a parent of the Syrian *R. x damascena.* Mirali, Aziz and Namuls (2012)i [cccxix] published the 'Genetic characterization of *Rosa damascena* species growing in different regions of Syria' and secondly in the research by Alsemaan, Albatal, Baydar and Almaarri (2011) in their '*Genetic Diversity and Qualitative Variation of Rosa damascena in Syria History & Utilisation'* [cccxx]

Similarly there is no mention of *Rosa phoenicia* in the excellent project, funded by The Syria Trust for Development (FIRDOS), *'The revival of Damascus rose production and the protection of local variety in the Marah region'* which was completed in 2011. 'Marah is one of the oldest villages that specialise in growing the Damascus Rose and manufacturing its products. Continuous drought, however, is affecting the growth of Damascus Rose in Marah. It is important to increase the areas where Damascus Rose is planted to ensure the species continues in this historical growing region'. The project not only funded the nurserymen themselves, but also the sales, marketing and branding of the end product. The project's notes state that 'Rosa *damascene*, or Damascus Rose, is a hybrid of *Rosa gallica* with *Rosa phoenicia* which was bred in Asia Minor and distributed throughout Syria, the Near East and the Middle East.

In summary despite the depth of research and its practical application, why when the parentage of the Damask, *R. x damascena* was firmly established in 2000 (Iawata et al 2000) [cccxxi] do the Syrians still insist that *Rosa phoenicia* is one of the parents? Why is there no mention in the Syrian research of *Rosa fedschenkoana*, the established remontant pollen parent? Are the historic references to *Rosa phoenicia* to be believed? The parentage of the Syrian Damask has a direct effect on its ability to produce rose oil and the quantity and quality of that rose oil. Prior to embarking on a programme to reintroduce, or restore or conserve the Syrian

Damask it would appear pragmatic to ascertain the parentage of the Syrian forms of the Damask to see which form should be selected, which might be improved or indeed which of the old forms should be conserved.
To that end, using the model worked up in the 'Silk Road Hybrids', this project is seeking to bulk up a stock of the best of the Syrian assessions, of *Rosa x damascena,* those that Abu Bilal says produce a form where the smell is headier, the quality is better, and rose oil production is greater, sufficient to be able to donate sufficient plants to the Syrian rose nurserymen, for them to reconstruct new, economically viable, rose fields.
There is precedent for the project. UNESCO, and a German NGO, sponsored a scheme in 2004, that introduced *Rosa x damascena* and rose oil production into a war ravaged, Afghanistan.
Stage one of the project is the collection of rose hips from Syria. In fact from six regions that previously grew the Damask. There will be some plants that are still growing in or around the old rose fields shown on the map below located near: Al Mrah, Emah, Issal, Masrabah, Nankoos and Bab Alnayrab
I am seeking small samples (7-10) of rose hips of the Damask rose, and also hips from *R. moschata*, *R. phoenicia and R. abyssinica*. A maximum of ten hips should be placed in a brown envelope and sent to me personally.
Postage will be refunded. The seed is to be germinated at Thenford in Oxfordshire, subjected to DNA analysis at the University of Bath and grown-on in rose trials near Oxford in the U.K., before being reintroduced to Syrian growers as 'suckers' or 'briars'.



[Map 20] The traditional areas of the nursery production of *R. damascena* in Syria

Appendix 1.

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Distribution and Checklist of the Rose species of Central Asia

Accepted Name	Synonym	Remontant	Afghanistan	Armenia	Azerbaijan	Egypt	Iran	Iraq	Israel	Kazakhstan	Kyrgyzstan	Pakistan	Syria	Tajikistan	Uzbekistan	Turkey	Turkmenistan	Palmir, Alai, Tien Shan
Rosa x alba L. *(4)*	*Rosa alba flore simplici*			7	7	7	7	7				6	7			2,7		
	Rosa alba L.																	
	Rosa usitatissima Gaterau																	
	R. proocera Salisb.																	
Rosa arvensis Huds.	*Rosa arabica* (Crép. ex Boiss.) Déségl.															7		
	Rosa arvensis Huds.																	
	R. arvensis ovata																	
	R. arvensis var. ovata Desv.																	
	R. arvensis var. pilifolia (Borbás) R. Keller																	
Rosa arvensis x R. phoenicia (1)																2		
Rosa arvensis x R. phoenicia (1)																2		
Rosa banksiae R. Br. In Ait., var *normalis* Regel	Single White Banksian											6				2		
Rosa banksiae Aiton *(1)*																2		
Rosa banksiae Aiton *var. lutea Lindl. (1)*																2		
Rosa beggeriana Schrenk ex Fisch. & C.A. Mey.	*Rosa anserinifolia* Boiss.	*R14*	1				1	1,15				1,6					1	1
	Rosa cabulica Boiss.																	
	Rosa daenensis Boiss.																	
	Rosa iliensis Chrshan.																	
	Rosa lacerans Boiss. & Buhse																	
	Rosa latispina Boiss.																	
	Rosa lehmanniana Bunge																	

			AF	AM	AZ	EG	IR	IQ	IS	KZ	KY	PK	SY	TS	UZ	TU	TK	PA
	Rosa mitis Boiss. & Buhse																	
	Rosa operta Sumnev.																	
	Rosa silverhjelmii Schrenk.																	
Rosa bracteata J.C.Wendl.	*Rosa macartnea* Dum.	*R7*										13						
Rosa brunonii Lindley	Himalayan Musk Rose		1									1, 6						1
	Rosa brunonis Wall.											7						
	Rosa clavigera H. Lév.											7						
	Rosa moschata var. *nepalensis* Lindl.											7						
	Rosa napaulensis Andr.											7						
	Rosa nepalensis Lindl. ex Steud.											7						
	Rosa pubescens Roxb.											7						
Rosa canina L. (21)	Dog Rose		1	1	1		1			1	1	1,6,13		1	1	1,2	1	
	see link and App. 1 for 169 more syns.																	
400 forms																		
	Rosa belgradensis Pancic																	
	Rosa leucantha Loiseleur																	
	Rosa pseudoscabrata Bllocki ex R.Keller																	
	Rosa sarmentacea Woods																	
	Rosa sphaerica Grenier																	
	Rosa surculosa Woods																	
Rosa canina x *R. dumalis subsp. boissieri*																2		
Rosa centifolia L. *(4)*	*Rosa gallica var. centifolia* Regel						7									2		
Rosa cinnamomea L	*Rosa majalis* Herrmann				1					1	1			1	1	2	1	
	Cinnamon Rose																	
	May Rose																	
Rosa clinophylla Thory	*Rosa involucrata* Roxburgh ex Lindley											6						
Rosa damascena Miller var. Trigintipetala *(17)*	Kazanlik	*R7*														2		
Rosa x damascena (1)	*Rosa belgica* Mill.							7				13				2		
	Damask Rose																	
Rosa dumalis Bechst (25)	*Rosa canina* L. var. *dumalis* (Bechst.) Hayek															2		
	Rosa vosagiaca agg. Vogesen-Rose																	

		AF	AM	AZ	EG	IR	IQ	IS	KZ	KY	PK	SY	TS	UZ	TU	TK	PA
	Rosa caésia Sm. agg. Lederblättrige Rose																
	R. uriensis (Christ) Puget. Uri-Rose.																
	R. canina L. var. *dumalis* (Bechst.) Hayek																
Rosa dumalis Bechst (Crépin) Ö. Nilsson var. boissieri (15)																	
Rosa dumalis Bechst. *subsp. boissieri* (Crépin)															2		
Rosa dumalis Bechst. *subsp. boissieri*															2		
Rosa dumalis var. boissieri															2		
Rosa ecae Aitch	*R. xanthina var ecae (Aitch*	1									1,6						1
	Rosa x *ecae* Hort.																
	Rosa mogoltavica Juz.																
	Rosa pedunculata Kult.																
Rosa elymaitica Boiss. & Hausskn. (2)	*Rosa elymaitica* var. *tomentella* Boiss.					7,15	7								2,7		
	R. albicans Godet ex Boiss					7	7								2,7		
	R. albicans var. *flexicaulis* Godet et Boiss.					7	7								2,7		
Rosa fedtschenkoana Regel	*Rosa caraganifolia* Sumn	13							1	1			1	1,7	2	7	1
	Rosa coeruleifolia Sumn.																
	Rosa epipsila Sumn.																
	Rosa lavrenkoi Sumn.																
	*Rosa lipschitzii*Sumn.																
	Rosa oligosperma Sumn.																
Rosa filipes Rheder & Wilson	*Rosa tatsienlouensis* Cardot																
Rosa foetida J. Herrm. (12)	*R. lutea*(Miller) Austrian Brier/Yellow					1	1				1,6		1	1	1,2		
	Rosa eglanteria Redouté & Thory																
Rosa foetida x R. hemisphaerica (1)															2		
Rosa foetida'Persiana'	Persian Double Yellow													1	1,2		
Rosa freitagi						16								16	16		
Rosa gallica L. (4)	*Rosa rubra* Lam.														2		
Rosa glabrifolia C.A. Mey ex Rupr.	*Rosa majalis* var. *glabrifolia* C.A.Mey								7						2		
Rosa heckeliana subsp. Vanheurckiana																	

			AF	AM	AZ	EG	IR	IQ	IS	KZ	KY	PK	SY	TS	UZ	TU	TK	PA
Rosa heckeliana Tratt. (5)																2		
Rosa hemisphaerica J. Herrm. (9)	*R. rapinni*Bois & Ball			1			1,15					1,6				2	1	1
	Rosa sulphurea Ait.																	
	Rosa sulphurea Dryand																	
	Yellow Centifolia																	
Rosa hirtissima Lonacz (12)				7												2		
Rosa iberica Stev.	*R. rubiginosa* var. *iberica* (Stev.) Bois			1	1		1	1								1,2	1	
Rosa iberica Stev., Bieb. (4)																2		
Rosa ilensis (Chrsham)	*R. beggeriana* var. *slverhjelmii* (Crepin)										1			1	7		1	
Rosa kokanica (Regel) Regel ex Juz.	*R. xanthina var. kokanica* (Regel) Boul.)		9					9		9		9			1	2		1
	Rosa divina Sumn.																	
	Rosa ovczinnikovii Koczk.																	
	Rosa platyacantha var. *kokanica* Regel																	
	Rosa platyacantha var. *variabilis* Regel																	
Rosa kopetdaghensis Meff.	*R. hemisphaerica* var. *rapinii* x *R. persica*																7,17	
Rosa lacerans							7					6,13		7	7		7	
Rosa laevigata Michx.	Mardan Rose																	
	Rosa argyi H.Lév.																	
	Rosa cucumerin Tratt.																	
	Rosa sinica Ait.																	
	Rosa ternata Poir.																	
Rosa laxa Retz var. harputense T. Baytop	Kişmirî rose	*R12*														12		
Rosa macrophylla Lindley											1	1,6		1				1
Rosa mollis Smith			1	1	1		7				1		1	1	1	1	1	
Rosa montana Chaix ex Vill.																2		
Rosa montana Chaix,subsp. *woronowii* (Lonacz.)																2		
Rosa montana x R. dumalis (1)																2		
Rosa moschata Miller	Musk Rose	*R7*	1			1	1	1				6,13				1		
	Rosa moschata Herrm.																	
	Rosa ruscinonensis Grén. & Déségl.																	

			AF	AM	AZ	EG	IR	IQ	IS	KZ	KY	PK	SY	TS	UZ	TU	TK	PA
	Rosa abyssinica (R.Br.)																	
	Rosa moschata var. *abyssinica*																	
	Rosa arborea Pers.																	
	Rosa broteroi Tratt.																	
	Rosa brownii Tratt.																	
	Rosa manueli Losa																	
	Rosa nepalensis Andrews																	
	Rosa opsostemma Ehrh.																	
	Rosa pissardi Carr.																	
	Rosa recurva Roxb.																	
	Rosa sempervirens																	
Rosa moschata plena	*R. glandulifera Roxb.*	*R7*					13											
Rosa multiflora Thunb.												6				2		
Rosa multiflora var. carnea												6						
Rosa nanothamnus Boulenger	*R. webbiana var microphylla* Crép		1									1,6		1	1		1	1
Rosa odorata (Andrews) Sweet																2		
Rosa orientalis Dupont ex.Ser	*R. heckliana* subsp.*orientalis*(Dupont)Meikle)						1,9	1,9								1,9		
	Rosa armena Boiss.															10		
	Rosa atropatana Sosn.															10		
	Rosa hakkariensis Mandenova															10		
	R. heckeliana subsp. *orientalis* Meikle															10		
	R. heckeliana subsp. *vanheurckiana* (Boiss.)															10		
	Rosa vanheurckiana Crep. ex Boiss.															10		
	Rosa vanheurckiana var. *barbata* Kit Tan, Yildirim & Ziel. (synonym)															10		
Rosa phoenicia Boissier	*Rosa chlorocarpa* Fenzl & H. Braun	*R7*						9					9			9		

		AF	AM	AZ	EG	IR	IQ	IS	KZ	KY	PK	SY	TS	UZ	TU	TK	PA
Rosa pulverulanta	Pine-Scented Rose					15									2		
	Rosa glutinosa Sibth. & Sm.																
	Rosa glutinosa ssp. glutinosa																
Rosa primula Boulenger	*R. ecae* subsp. *primula* (Boul.) Roberts)													2	2		
	The Incense Rose																
Rosa rubiginosa L	Sweet Briar, Eglantine		1	1								1			1		
	Rosa eglanteria L.																
Rosa sericea L	*Rosa sericea f. chrysocarpa* (Rehd.)Haw										6						
	Rosa sericea f. glabrescens Franch.																
	Rosa sericea f. *glandulosa*Yu & Ku																
	Rosa tetrapetala Royle																
	Rosa wallichii Tratt.																
Rosa sherardii	Downy Dog Rose	1		1							1			1	1	1	
	Rosa omissa Déségl																
Rosa spinossissima L.	*R. pimpinellifolia, Scots Rose,Burnet Rose*										6				1		1
	Rosa lutescens var. spinosa Pursh										6		1			1	1
	Rosa myriacantha DC																
	Rosa rubella																
	Rosa rupincola Fisch. ex Sweet																
	Rosa spinosissima var. hispida (Sims) Koehne																
	Rosa sp. var. laevis Rouy																
	Rosa sp. var. mathonettii (Crép.) Rouy																
Rosa villosa L.	*Rosa pomifera* J. Herrmann (					15											
Rosa webbiana Wall. ex Royle	*Rosa curvata* Sumn. *R15*								1	1							
	Rosa dawoensis Pax & K. Hoffm.																
	Rosa kirsanovae Sumnev.																
	Rosa leiophylla Sumn.																

		AF	AM	AZ	EG	IR	IQ	IS	KZ	KY	PK	SY	TS	UZ	TU	TK	PA
Rosa webbiana Wall. ex Royle contd.	*Rosa longipedicellata* Sumn., nom. inval.																
	Rosa magnifica Sumn.																
	Rosa maracandica Bunge																
	Rosa nudiflora Sumn.																
	Rosa nummularia Sumn.																
	Rosa oligacantha Sumn.																
	Rosa pimpinellifolia Herb. Hook. Thoms.																
	Rosa pycnantha Sumn.																
	Rosa pyricarpa Sumn.																
	Rosa rectinervis Sumn.																
	Rosa rubens Sumn.																
	Rosa scoparia Sumn.																
	Rosa tytthantha Sumn.																
	Rosa tytthotricha Sumn.																
	Rosa unguicularis Bertol.																

Appendix 2

Research into whether remontant hybrids transmigrated along the Silk Road from China, prove to be inconclusive. However, the research detailed in the table below demonstrated that the Damask was depicted by the Uzbeks and Persians in their carpets and ornament.

[Table 22.] Graphic Evidence of Rose Hybrids from Historic Cultural Artefacts found along the Silk Road

Ref	Date Illus	Medium	Location Found	Artefact Archived	Content	Stylised/Real	Single/Double	Colour	Ident.
1. cccxxii		Wall Painting	Tarim Basin		Bodhisattva; in elaborate crown	Stylised	Semi Double	Victorian pink	
2 cccxxiii		Wall Painting	Tarim Basin		Bodhisattva; in elaborate crown	Stylised	Semi Double	Victorian pink	
3 cccxxiv		Wall Painting	Tarim Basin		Uighur Prince; rose in hand	Stylised	Single, 5 petals	Victorian pink	
4 cccxxv		Wall Painting	Tarim Basin		Uighur Princess; rose in hand;	Stylised	Single, 5 petals	Victorian pink	
5 cccxxvi	750	Wall Painting	Tarim Basin		Figure of a Devata; flower clasped in her hand	Stylised			
6 cccxxvii	900	Wall Painting	Tarim Basin		Deity offering flowers				
7 cccxxviii		Wall Painting	Tarim Basin		Uighur Prince; stylised rose + bud in hand; single 5 petals	Stylised	Single, 5 petals	Victorian pink	
8 cccxxix		Wall Painting	Tarim Basin		Uighur Princess; stylised rose + bud in hand; single 5 petals	Stylised	Single, 5 petals	Victorian pink	
9 cccxxx		Wall Painting	Tarim Basin	Bezelik, Temple G	Flower and rose bud	Stylised			
10 cccxxxi	850	MS painting on leaf	Tarim Basin	Khoho, Temple K	5 petalled flower top of RH creeper;	Stylised	Single, 5 petals	Rusty pink petals,	
		Manichean Book						white stamens	
11 cccxxxii	850	Painting on Silk	Tarim Basin	Toyok	Hand holding double flower				
12 cccxxxiii	900	Wall Painting	Tarim Basin	Turfan region	Head of a Bodhisattva; Says reminiscent of lotus blossom; I think not.	Semi Real	Very Double	White, cream	
							Quartered		
13 cccxxxiv	420	Wall Painting		Gainsu Prov	Bodhisattva & Apsarail with preaching Buddha				
				E. Wall Cave 169	and kneeling foreigner; Rose like flowers				
14 cccxxxv	750	Posy of artificial silk gauze flowers		Astana Cemetery, Turfa	Xiajiang Huighur Autonomous Regional Museum				
15 cccxxxvi	400	Manuscript		Loulan	Notes dwindling Water Resources in Loulan in 4th. C				
16 cccxxxvii	300	Mural on Shrine	Tarim Basin	Viran, Xinjiang	after Stein 1912		Stylised	Semi Double	
17 cccxxxviii	-200				Old pond with remains of an arbour		17	-200	
18 cccxxxix	-104	Manuscript			Shanglin Gardens built by Wudi, c -104, contained 3000 varieties of flowers and		Double	Monochrome	

					fruit trees				
20 [cccxl]	1600	Painting on Silk			Persian Beauty, showing vase of roses, with rose buds and leaves				
21 [cccxli]	1800	Scroll Painting on Silk by Leng Mei		National Palace Museum Taiwan	Ladies in a Garden pavilion playing chess, Roses trained over a trellis a popular seasonal screen				
22 [cccxlii]	-207	Poetry			Shang-lin Park; Ssu-ma-Hsiang court poet to the Han Emperor Wu-ti				
23 [cccxliii]	-207	Manuscript			First flowering catalogue of the Chinese garden of early delights				
24 [cccxliv]	-100	Manuscript			Silk Road began by Zhang Qian sent by emperor Wu Han to explore west				
25 [cccxlv]	900	Wall Painting	Uzbekistan	Sengrim Terrace of Temple 10	Female Deity with bowl of flowers and 'Tuscany Superb' in her hair. Following pages; many illustrations of stylised flowers, some appear to be roses	Semi Stylised	Double	Deep claret	
27 [cccxlvi]	1550	Scroll	Guandong		By Sun Kehong, 1533-1611 Flowers & Fruits	Real	Single	Creamy white	R. sericea? R. brunonii?
28	1550					Real	Double	Strong rose pink	V. thorny, not chinensis like
29 [cccxlvii] [cccxlviii]		Water Colour on Paper			Jacquin named R. chinensis; merely one of a whole range of similar hybrids; not a type	Real	Double	Deep maroon	29[cccxlix]

Appendix 3.

This appendix details two further species that exhibit limited remontancy as debated in the Discussion (p.144)

Remontancy in rose species present in Central Asia in addition to *Rosa fedtschenkoana*.

Rosa beggeriana [Figs 100 & 101]

A very variable species (composite), especially in the type of indumentums (hairs or down on the plant or leaf). In spite of its variability the species is rather easy to recognize by small fruits, sepals often deciduous together with the top of hypanthium, and yellowish, usually curved and uniform prickles, white, rather small flowers. [Fig.101]

[Fig. 100] *Rosa beggeriana.*

[Fig. 101] *Rosa beggeriana,* Hips.

[Table 23]. *R. beggeriana.* Taxonomic Description

Accepted Name	Synonyms	Common Name
R. beggeriana	*R. anserinaefolia* *Rosa anserinaefolia Boiss. synonym* *Rosa anserinaefolia Crép. synonym* *R. beggeriana genuina* *Rosa beggeriana Schrenk ex Fisch. & C.A. Mey.* *Rosa beggeriana var. genuina Crép. synonym* *R. silverhielmii* *Rosa silverhielmii Schrenk synonym* *Rosa silverhjelmii Schrenk*	

[Table 24]. *R. beggeriana* Botanical description

Flowers	4 – 8 petals
Size	3 cms
Borne	Singly in clusters
Colour	White
Scent	Strong
Flowering period	Summer flush with scattered later bloom
Hips	Spherical, red or brownish-red fruits are 4 to 5 mm in diameter
Growth	Arching, bushy, suckers on its own roots
Spines	Thornless
Foliage	Small, matte, dark green foliage. 5 to 9 leaflets.

[Map. 21]. Distribution of *R. beggeriana*: Iran, Afghanistan, Kyrgyzstan [Fig.14], Pakistan (N. Baluchistan, Chitral, Gilgit, Swat), Kashmir, India (Uttar Pradesh). Turkey, Iran, Kyrgyzstan, Kazakhstan, Afghanistan, Western Pakistan and the Tian Shan Mountains of Central Asia. Iran, Middle Asia, Afghanistan, W Pakistan, Kashmir, W China. Sources[cccl][cccli].

Rosa brunonii

[Fig. 102] *Rosa brunonii,* flowers

[Fig. 103] *Rosa brunonii* Hips. National Gardening Association

[Fig.104] *Rosa brunonii*, growing in the wild. Central Asia

[Table 25] *Rosa brunonii.* Taxonomic Description

Accepted Name	Synonym	Common Name
Rosa brunonii Lindl.	*Rosa brunonis* Wall.	
	Rosa clavigera H. Lév.	*Himalayan Musk Climber*
	Rosa moschata var. nepalensis Lindl.	*Himalayan Musk Rose*
	Rosa napaulensis Andr.	*Himalayan Briar*
	Rosa nepalensis Lindl. ex Steud.	*Mr. Brown's Rose*
	Rosa pubescens Roxb.	*Rosa brunonii Lindl.*

Table 27. *Rosa brunonii*. Botanical Description

Flowers	Single
Size	3 – 6 cms
Borne	Large loose flat topped clusters
Colour	Creamy white
Scent	Strong
Flowering period	Once only
Hips	Long reddish invertly egg shaped
Growth	Climbing 15.0m + Partly evergreen
Spines	Hooked thorns
Foliage	Long pale green, ovate to elliptic, Seven leaflets
Ploidy	Diploid

[Map.21] *Rosa brunonii.* Distribution Afghanistan, Kashmir, Bhutan, Burma, SW China Himalaya, Yunnan and W. Szechuan.

Rosa webbiana

A species rose from the *Cinnamomeae section*, Webb's Rose is a common shrub rose, widely distributed, and growing from 1500 m up to 4000 m. The species was used in the former Soviet Union for breeding purposes. Two cultivars bred for their hips have been released: 'Voroncovskij' (*R webbiana*-selection) and 'Bezshipnyj' (*R. webbiana x R. rugosa* L.) (Albrecht 1993)[ccclii]

Native to the western Himalayas from the Pamir in central Asia to Kashmir, Tibet and Afghanistan. "The closely related species *R. bella* and *R. sertata* are found in western and northern China. In spite of numerous separations of related forms in recent years, this polymorphic[cccliii] species is still rather broadly interpreted. Further studies and, in particular, a comparison of the Soviet forms with those of the Himalayan *R. webbiana* have been required. (Flora of the U.S.S.R., Vol. X (1971)[ccccliv] .Confusion has arisen largely due to the reliance on the morphological characteristics of a wide distribution of similar plants synonyms have been given to the same plant in different locations and that same name given different plants in the same locations

[Fig.105] R. *webbiana*

[Fig. 106]. *Rosa webbiana* Thenford form displaying remontancy late September 2015

Distribution; N. India, Kashmir, Nepal, Pakistan, Afghanistan and Mongolia western Himalayas from the Pamir in central Asia to Kashmir, Tibet and Afghanistan.

[Fig 107]. *Rosa webbiana*. Hips 2015

[Fig.108]. *Rosa webbiana growing in a village in Shyok River Valley ahead of Khaplu, Pakistan at an elevation of 10,000 ft*

[Table. 27] *Rosa webbiana* Taxonomic Description

Accepted Name	Infraspecific taxon:	Common Name
Rosa webbiana Wall. ex Royle	*Rosa webbiana* var. *genuina* Crisp.	Webbs Rose
http://www.theplantlist.org/tpl/ 27807459	*Rosa webbiana* var. *glandulosa*.	Laddaakhi-Sevati.
	Rosa webbiana var. *latifolia*	
	Rosa webbiana var. maracandica (Bunge) H. Christ	
	Rosa webbiana var. *microphylla*	
	Rosa webbiana var. *pustulata* H. Christ	
	Rosa webbiana var. *webbiana*	
	Rosa webbiana var. *winterbottomii* Boulenger	
	Rosa webbiana subsp. *wulffii* Almq.	

[Table 28] *Rosa webbiana* Botanic Description

Flowers	Small to medium, single, (4-8) petals
Size	5 cms
Borne	Loose clusters on slender 3cms. stalks
Colour	Dark red, Pink, Lilac pink
Scent	Moderate, linseed oil fragrance.
Buds	Pointed
Flowering period	Spring or summer flush with scattered later bloom.
Hips	Fruit bottle-shaped to globular, red.
Growth	Tall, arching. Height of up to 6' 7" (up to 200 cm). Width of up to 8' 2" (up to 250 cm).
Spines	Very few, straight thorns.
Foliage	Medium, matte, dark green foliage. 5 to 9 leaflets.
Ploidy	DNA Ploidy=4 Published Ploidy=2

References

[i] Pliny the Elder, *Naturalis Historia citing Callimachus and Apolonia*, *Natural History, XXI, 12; X, 86; XXI, 116; XXIV.167.Volume I: Books 1-2.* Translated by H. Rackham. Loeb Classical Library Harvard University Press, 1938.

[ii] The Metropolitan Museum of Art, New York. *Giacomo Barozzi da Vignola 16th. Century Architect,* Available from *www.metmuseum.org/art/collection/search/202115* 2000-2016 Accessed 18.08.16

[iii] Harkness P. *Roses - A Brief History.* The Historic Rose Journal Autumn 2007 Historic Rose Group Royal National Rose Society 2007

[iv] The National Gallery *Agnolo di Cosimo (called Bronzino*) Available at https://www.nationalgallery.org.uk/artists/bronzino Accessed 19.10.16

[v] Livius.org *page created in 2005; last modified on 20 January 2017. Heliogabalus* Available at http://www.livius.org/he-hg/heliogabalus/heliogabalus.htm Accessed 19.10.16

[vi] Mello M. *Rosae Il fiore di Venere* Napoli Arte tipografica Naples 2003

[vii] Ibid vi

[viii] Simón, Pérez. *A Victorian Obsession:* The Pérez Simón collection, Leighton House Museum, London, 14 November 2014-29 March 2015. Simón, showed this work for the first time in over 100 years, at Leighton House in London during 2014/2015

[ix] Hobhouse, P. *Gardens of Persia* Cassell 2003 p.93

[x] Jashemski, W., *The Gardens of Pompeii, Herculaneum, and the Villas Destroyed by Vesuvius* 2 vol. New Rochelle, New York: Caratzas Bros., 1979, 1993.

[xi] Hehn, V. *Cultivated Plants and Domesticated Animals in their Migration from Asia to Europe*: Historico-linguistic studies (London, 1885) in John Benjamins Publishing, 1976

[xii] Rechinger K. Ed. *Flora Iranica* Vols 1 – 181 Natural History Museum Vienna, Austria 1963-2017

[xiii] Zhengyi W., Raven P., & Deyuan H., *Flora of China* Science Press (Beijing) &Missouri Botanical Garden (St. Louis) (China and USA) 1994 online since 2004. Accessed 19.02.15

[xiv] Ghazanfar, A. Ed. *The Flora of Iraq* Royal Botanic Gardens, Kew, UK. 1960-2017

[xv] Ebel, A., Kupriyanov, A., Khrustaleva, I., *New Records to The Vascular Flora of Kazakhstan (Central Asia*). Polish Botanical Journal, 60(2), pp. 191-195. The Journal of Polish Academy of Sciences, W. Szafer Institute of Botany (2015). Retrieved 11 Sep. 2017, Available from doi:10.1515/pbj-2015-0018 Accessed 11.09.17

[xvi] Sennikov A., Uotila, P. *Floristic studies in Kyrgyzstan* 2017 Available from https://www.luomus.fi/en/floristic-studies-kyrgyzstan Accessed 09.09.2016

[xvii] Ali Bassam Khalaf, N. *Flora and Fauna in Palestine.* 'Gazelle': *The Palestinian Biological Bulletin*. ISSN 0178-6288. Number 91, July 2009, Rajab 1430. pp.1-31. Sharjah, United Arab Emirates 2009

[xviii] Stewart, *Flora of Pakistan* Available from http://www.tropicos.org/Project/Pakistan 1982 Accessed 11.11.2016

[xix] Post. G., *Flora of Syria, Palestine and Sinai; from the Taurus to Ras Muhammad, and from the Mediterranean Sea to the Syrian Desert*. Beirut, Syria, Syrian Protestant College 1896

[xx] Tajikistan National Center for Biodiversity and Biosafety (NBBC) *Flora of the Tajik SSR.* 2003 Available from http://www.biodiv.tj/en/page?cat=80 Accessed 10.01.2017

[xxi] Davis P *Flora of Turkey* Edinburgh University Press 2016

[xxii] Kurbanov, D. *Flora of Turkmenistan* Biogeography and Ecology of Turkmenistan Volume 72 of the series Monographiae Biologicae 1994 pp 105-128

[xxiii] Sennikov, A., Komiljon, S, S. Tojibaev F., Khassanov, O, O. Yu, N. Beschko *The Flora of Uzbekistan Project 2017* Available from http://biotaxa.org/Phytotaxa/article/view/phytotaxa.282.2.2 2017 Accessed 11.01.17

[xxiv] Polunin, O. Stainton, A. *Flowers of the Himalaya* OUP 1997 ISBN 10: 0195641876 / ISBN 13: 9780195641875

[xxv] Wilson E. H., *A Naturalist in Western China* Methuen 1913

[xxvi] Iwata H[1], Kato T, Ohno S. *Triparental origin of Damask roses.* Gene. 2000 Dec 23;259(1-2):53-9.

[xxvii] Mattock R. *The Silk Road Hybrids* Transfer report. CASA University of Bath 2015

[xxviii] Cirigan B. *Tulips, Traders and Roses* World Regional Rose Conference, Hyderabad 2104 The Indian Rose Annual XXXI. pp96-142

[xxix] Cirigan B. *Tulips, Traders and Roses* World Regional Rose Conference, Hyderabad 2104 The Indian Rose Annual XXXI. pp96-142

[xxx] Philips R. & Rix M. *Roses* Pan 1988

[xxxi] Potter, J. *The Rose,* Atlantic Books 2011. P.57

[xxxii] Eisenman, S., Zaurov, D., Struwe, L. Medicinal plants of Central Asia [electronic resource]: Uzbekistan and Kyrgyzstan New York, NY: Springer, c2013

[xxxiii] Fedorov, *A Flora of Russia* Balkema 2011

xxxiv Komarov V., Bobrov, E., English, Book edition: *Flora of the U.S.S.R. (Flora SSSR).* 1971 Jerusalem: Israel Program for Scientific Translations, 1971.

xxxv Fedorov, *A Flora of Russia* Balkema 2011

xxxvi Eisenman, S., Zaurov, D., Struwe, L. *Medicinal plants of Central Asia [electronic resource]: Uzbekistan and Kyrgyzstan* New York, NY: Springer, c2013

xxxvii Tan, K., & Zielinski, J. (2010). *Two unnamed Turkish roses*. Phytologia Balcanica*, 16*(2), 221-225.

xxxviii Baytop *Medicinal and Aromatic Plants of the Middle*-East 2001 Springer 2014

xxxix Samiei, L. Naderi, R. Khalighi, A. Smulders, M. *Genetic diversity and genetic similarities between Iranian rose species*. Journal of Horticultural Science and Biotechnology 85(3) ·2010

xl Widrlechner, M History *and Utilization of Rosa damascena* Economic Botany Vol. 35, No. 1 (Jan. - Mar., 1981), pp. 42-58

xli Pliny the Elder *Naturalis Historia. The rose: twelve varieties of it.* Chap. 10. (4.) Loeb Classical Library

xlii Widrlechner, M. *History and Utilization of Rosa damascena* Economic Botany, Vol. 35, No. 1 1981, pp. 42-58 Published by: Springer on behalf of New York Botanical Garden Press

xliii Widrlechner, M. *History and Utilization of Rosa damascena* Economic Botany, Vol. 35, No. 1 1981, pp. 42-58 Published by: Springer on behalf of New York Botanical Garden Press

xliv Fabri, Felix *Fratris Felicis Fabri Evagatorium in Terrae sanctae, Arabiae et Aegypti peregrinationem*. Palestine Pilgrims' Text Society. 1848

xlv https://www.newscientist.com/article/dn6421-wind-carries-gm-pollen-record-distances/ Accessed 19.11.14

xlvi Eisenman, S., Zaurov, D., Struwe, L. *Medicinal plants of Central Asia [electronic resource]: Uzbekistan and Kyrgyzstan* New York, NY: Springer, c.2013

xlvii Louette, I. *Les origines botaniques et géographiques de Rosa moschata* Herrm. (Exposé donné lors de la 8e Conférence Internationale des Roses Anciennes; Lyon, 29 mai 1999.)

xlviii Ciragan, B. *Tulips, Traders and Roses* – Proceedings of the World Federation of Rose Societies, Hyderabad, India December 2, 2014 Indian Rose Annual XXXI 2015

xlix Remay A[1], Lalanne D, Thouroude T, Le Couviour F, Hibrand-Saint Oyant L, Foucher F. *A survey of flowering genes reveals the role of gibberellins in floral control in rose.* Theor. Appl. Genet. 2009 Sep;119(5):767-81. doi: 10.1007/s00122-009-1087-1. Epub 2009 Jun 16.

l Mattock, R. *The Silk Road Hybrids* Lecture. Proceedings of the World Federation of Rose Societies, Hyderabad, India December 2, 2014 Indian Rose Annual XXXI 2015

li Thomas, Graham Stuart. *The Old Shrub Roses* Dent 1962

lii Crépin, F. *Sketch of a new classification of roses* Journal of the Royal Horticultural Society Vol. 11 1889. pp217-228

liii Rehder, A. *Manual of cultivated trees and shrubs hardy in North America* New York Macmillan 1940

liv Ibid liv

lv Ibid lv

lvi American Museum of Natural History *Resources*. Available from https://www.amnh.org. Accessed 09.01.14

lvii Ibid lvii

lviii Ibid xxxix

lix Breeze, Z. *Phylogenetics of hybrid roses analysed by ISSR-PCR* University of Bath May 2011

lx Bruneau A., Starr J., Joly S., *Phylogenetic Relationships in the Genus Rosa: New Evidence from Chloroplast DNA Sequences and an Appraisal of Current Knowledge* Systematic Botany (2007), 32(2): pp. 366–378

lxi Fouge-Danezan M., Joly S., Bruneau A., Gao Xin-Fen., Zhang Li-Bing., *Phylogeny and biogeography of wild roses with specific attention to polyploids* Annals of Botany 115: 275–291, 2015 doi:10.1093/aob/mcu24

lxii Cloutier, S. Miranda, E. Ward, K. Radovanovic, E. Reimer, I . Walichnowski, A. Raju Datla, R. Rowland, G. Duguid, S. and Ragupathy R. *Simple sequence repeat marker development from bacterial artificial chromosome end sequences and expressed sequence tags of flax (*Linum usitatissimum *L.)* Theor Appl Genet. 2012 125(4): pp. 685–694.

lxiii Crespel L., Chirollet M., Durel C. E., Zhang D., Meynet J., Gudin S. (2002). *Mapping of qualitative and quantitative phenotypics traits in* Rosa *using AFLP markers*. *Theor. Appl. Genet.* 105 1207–1214. 10.1007/s00122-002-1102-2

lxiv Reddy, M. Sarla, N. Siddiq E. *Inter simple sequence repeat (ISSR) polymorphism and its application in plant breeding* Euphytica 128: 9–17, 2002. Kluwer Academic Publishers. © 2002

lxv Ellegren, H. *Microsatellites: simple sequences with complex* evolution *Nature Reviews Genetics* 5, 435-445 (June 2004) doi: 10.1038/nrg1348

lxvi Ibid xiv

lxvii Ibid xiv

lxviii Jabbarzadeh, Z.; Khosh-Khui M..; Salehi, H. and SAaberivand, A. *Inter simple sequence repeat (ISSR) markers as reproducible and specific tools for genetic diversity analysis of rose species.* African Journal of Biotechnology, vol. 9, no. 37, p. 6091-6095. (2010).

lxix Ibid xliii
lxx Ibid xliii
lxxi Brinkhuis, H., Schouten, S., Collinson, M., Moran, V., *Episodic fresh surface waters in the Eocene Arctic Ocean Article* in Nature 441(7093):606-9 · July 2006 DOI: 10.1038/nature04692 · Source: PubMed
lxxii Akhmetiev. and Beniamovski V. *Paleogene floral assemblages around epicontinental seas and straits in Northern Central Eurasia: proxies for climatic and paleogeographic evolution* Geologica Acta, Vol.7, Nos 1-2, March-June 2009, pp. 297-309 DOI: 10.1344/105.000000278
lxxiii Ibid xlii
lxxiv Ibid xxvi
lxxv Burbidge NT (1960) *The phytogeography of the Australian region.* Australian Journal of Botany *8*, 75-211.
lxxvi Fidelibus*, M.* Alle, T. *Desert Revegetation Project* San Diego State University 1993
lxxvii Hyatt P., Downer, R. *Identifying Plant Species*: A *Botanical Analysis Using PROC DISCRIM*. Louisiana State University, Baton Rouge, LA. U.S. Forest Service, Pineville, LA. Paper 199-27.
lxxviii Ibid iii
lxxix Asano; Yamasaki; Takuno; Miura; Katagiri; Ito; Doi; Wu; Ebana; Matsumoto; Innan; Kitano; Ashikari; Matsuoka *Artificial selection for a green revolution gene during japonica rice domestication.* Proceedings of the National Academy of Sciences of the United States of America. 108 (27): 11034–11039. 2011).
lxxx Ibid xliii
lxxxi *"World's Largest Plants Database Assembled"*. Available at discovery.com. 2010. Accessed 14.03.15
lxxxii Royal Botanic Gardens, Kew, *About the Index Kewensis*". International Plant Names Index. 2004.Avaiable from www.ipni.org/ik_blurb.htm Accessed 19.09.16
lxxxiii Iwata; H. Gaston, A., Denoyés, B. Araki, T., Remay, A., Thouroude, T., Jeauffre; J, Oyant, S., Foucher, F., *The TFL1 homologue KSN is a regulator of continuous flowering in rose and strawberry* The Plant Journal, 2011. DOI: 10.1111 / j.1365-313X.2011.04776.x 2011
lxxxiv Iwata; H. Gaston, A., Denoyés, B. Araki, T., Remay, A., Thouroude, T., Jeauffre; J, Oyant, S., Foucher, F., *The TFL1 homologue KSN is a regulator of continuous flowering in rose and strawberry* The Plant Journal, 2011. DOI: 10.1111 / j.1365-313X.2011.04776.x 2011
lxxxv Foucher, F., Hybrand-Saint Oyant, L., Denoyés, B., *RoKSN, a floral repressor, forms protein complexes with RoFD and RoFT to regulate vegetative and reproductive development in rose*. New Phytol. 2014 Apr;202(1):161-73. doi: 10.1111/nph.12625. Epub. 2013
lxxxvi Foucher, F., Hybrand-Saint Oyant, L., Denoyés, B., *RoKSN, a floral repressor, forms protein complexes with RoFD and RoFT to regulate vegetative and reproductive development in rose*. New Phytol. 2014 Apr;202(1):161-73. doi: 10.1111/nph.12625. Epub. 2013
lxxxvii Takeshi Kurokura1,Naozumi Mimida, Nicholas H. Battey, Timo Hytönen *The regulation of seasonal flowering in the Rosaceae* J. Exp. Bot. (2013)doi: 10.1093/jxb/ert233 First published online: August 8, 2013
lxxxviii Bradford E., Hancock J., Warner R. *Interactions of Temperature and Photoperiod Determine Expression of Repeat Flowering in Strawberry*. Journ. American Society for Horticultural Science March 2010 vol. 135 no. 2 pp. 102-107
lxxxix Ibid xxxi
xc Kornet D. *The Composite Species Concept: A Rigorous Basis for Cladistic Practice* Current Themes in Theoretical Biology pp 95-127 Life Sciences Group, University of Leiden 2005
xci A Dictionary of Zoology http://www.encyclopedia.com from Encyclopedia.com: http://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/cladogenesis-2 Retrieved October 28, 2016
xcii Ibid xxx
xciii Ibid xxvi
xciv Royal Botanic Gardens, Kew and Missouri Botanical Garden *The Plant List* Available from http://www.theplantlist.org/1.1/ Accessed 28.08 2016
xcv http://www.theplantlist.org/1.1/about/#accepted 28.08, 2016
xcvi *The Art of Gardening with Roses Book* (1991) Page 18.
xcvii Ibid xxvi
xcviii Pal, P. *Evaluation, Genetic Diversity, Recent Development of Distillation Method, Challenges and Opportunities of Rosa damascena: A Review.* Journal of Essential Oil Bearing Plants. 16. 1-10. February 2013
xcix *Syria's Damask rose is under threat*. Agence Presse in May 2016 https://www.thenational.ae/world/withered-by-war-syria-s-damask-rose-is-under-threat-1.203865 Abu Bilal, 52, [Fig.96] owned a distillery in Ain Tarma in the Eastern Ghouta Accessed 11.09.2017
c Wood, F. *The Silk Road Two Thousand Years in the Heart of Asia* September UCP. 2004

ci Jones, O. *Persian Ornament.* The Grammar of Ornament Dover 1987 Plate XLVII
cii Leslie and Gardiner. *The Roman Empire in Chinese sources* Rome, Bardi, 1996.
ciii Ibid xc
civ Hill, John E. *The Peoples of the West from the Weilüe 魏略 by Yu Huan 魚豢: A Third Century Chinese Account Composed between 239 and 265 CE.* Draft annotated English translation 2004 Available from https://depts.washington.edu/silkroad/texts/weilue/weilue.html Accessed 11.09.2017
cv Hanks G. *A review of production statistics for the cut flower and foliage secrotr 2015 (part of AHDB horticulture funded project* PO BO 002a AHDB horticulture ADHB 2015
cvi pRESS TV http://www.iran-daily.com/News/154714.html Retrieved 03.11.16
cvii Mackenzie G. *Roses taken out of inflation index* Horticultural Week 25 March 2011
cviii Caissard, J Bergougnoux, V Martin, M., Mauriat, M., Baudino, S. *Chemical and Histochemical Analysis of 'Quatre Saisons Blanc Mousseux', a Moss Rose of the Rosa × damascena Group* Annals of Botany", Vol. 97, pp. 231-238.
cix Kole, C. editor *Wild crop relatives: genomic and breeding resources : plantation and ornamental crops* Heidelberg ; New York : Springer Verlag, 2011.
cx Mattock R. *The Silk Road Hybrids* Transfer report. CASA University of Bath 2015
cxi Roskov Y. *Catalogue of Life:* http://www.catalogueoflife.org/ 28th July 2016
cxii Ibid xxvi
cxiii Gebundene Ausgabe *Rosenverzeichnis Rosarium* Sangerhausen, 4. Edition 2011
cxiv Roskov Y. *Catalogue of Life:* http://www.catalogueoflife.org/ 28th August 2016
cxv Trudy *Rosa fedtschenkoana Regel Imp. S.-Peterburgsk. Bot. Sada 5(2): 314 1878*. record 27804855 Tropicos
cxvi Trudy Imp. Bot. Sada Petra Velikago. http://fig.lib.harvard.edu/fig/?bib=003847275 Superseded by: Trudy Glavn. Bot. Sada Library of Congress Number: QK1.T8874 BPH Number:906.13
cxvii Quest-Ritson C. & B. *RHS Encyclopedia of Roses* D & K 2003 p.147
cv Marriot 2006 (personal communication)
cxix Eisenman, S., Zaurov, D., Struwe, L. *Medicinal plants of Central Asia* [electronic resource]: Uzbekistan and Kyrgyzstan New York, NY: Springer, Retrieved 11.03.205 2013
cxx Philips & Rix Roses Pan 2004
cxxi Ibid xcv
cxxii Ibid xcv
cxxiii Roskov Y. *Catalogue of Life:* http://www.catalogueoflife.org/ Retrieved 28th July 2016
cxxiv Ibid xcv
cxxv Eisenman, S., Zaurov, D., Struwe, L, *Medicinal Plants of Central Asia: Uzbekistan and Kyrgyzstan* Springer 2012 p.216
cxxvi Magdalena O. *Dendrological potential of Ephedra equisetina from Zaravshan Mountains, Tajikistan in climate change studies* Tadeusz Niedźwiedź, Oimahmad Rahmonov Faculty of Earth Science, University of Silesia, Bedzinska Str60, 41200 https://www.researchgate.net/publication/260187650 Accessed Nov 6, 2016.
cxxvii Łazarski, G R*osa gallica (Rosaceae) in the Świętokrzyskie Mountains and adjacent areas (Małopolska Upland) – occurrence and threats* Article XIII Fragmenta Floristica et Geobotanica Polonica. 2016 **23** (1): 3-11.Accessed 11.02.2016
cxxviii Essential Oils Company *History of the Rose* Available from essentialoilscompany.blogspot.co.uk/2008/08/history-of-rose.html Accessed 15.08.2018
cxxix Kahl, O. *The Sanskrit, Syriac and Persian Sources in the Comprehensive Book of Rhazes* Brill 2015 p.481
cxxx Herbs2000.com *A practical guide for nutritional and traditional health care. Available from* http://www.herbs2000.com/flowers/r history.htm Accessed 12.1.216
cxxxi Rechinger K. Ed. *R. gallica*. T̲ābeti (pp. 643-44) has reported it from Arāk and Minudašt (in Gorgān province), and two Persian names: *sag-gol* (lit. "dog rose") in Minūdašt, and *gol-e rašti* "Rašt rose." *Flora Iranica* Vols 1–181 Natural History Museum Vienna, Austria 1963-2017
cxxxii Louette *Les origines botaniques et géographiques de Rosa moschata Herrm.* Exposé donné lors de la 8e Conférence Internationale des Roses Anciennes; Lyon, 29 mai 1999.
cxxxiii Hermann J. *Dissertatio inauguralis botanico-medica de rosa: quam auspice deo, consentiente gratiosa facultate medica pro licentia gradum, honores atque privilegia doctoralia …* Ex officina Joh. Henrici Heitzii, 1762
cxxxiv Ibid xxvi
cxxxv Backer & Van Brink 1, 1963; Hegi IV (2), 1923; Ochse & Van den Brink 1931, 1005 pp.; Terra 1966, 107 pp.; Vul'f & Maleeva 1969, 566 pp.
cxxxvi Ibid cvii
cxxxvii Ibid xxxiii
cxxxviii Ibid cxii

cxxxix Juniper, B. and Mabberly, D. The Story of the Apple. Portland, Ore.: Timber Press 2006.

cxl Cramp, S. & Simmons, K (Eds) *Handbook of the Birds of Europe, the Middle East and North Africa: Tyrant Flycatchers to Thrushes v.5:* Hardcover – 21 Apr 1988 p.989 p.1011

cxli Arnold, Matthew. *Sohrab and Rustum* in *Poetical Works* Oxford University Press, 1950. pp.488–493

cxlii Shavkat Rakhmatullaev, Frederic Huneau, Jusipbek Kazbekov, Philippe Le Coustumer, Jamoljon Jumanov, et al.. Groundwater Resources Use and Management in the Amu Darya River Basin (Central Asia). Environmental Earth Sciences, Springer, 2010, 59, pp.1183-1193.Avaiable https://hal-insu.archives-ouvertes.fr/insu-00442903 Accessed 2016.12.16.

cxliii Spuler, B. *Āmū Daryā* , Encyclopædia Iranica, online ed., 2009 Available from www.iranicaonline.org/articles/spuler-bertold Accessed 03.04.2014

cxliv *Arapov A.V. Gur Emir mausoleum* Silk Road Adventures 2016 Available at http://www.silkadv.com/en/content/gur-emir-mausoleum Accessed 09.09.2016

cxlv Brett, M. Fentress E., *The Berbers (Peoples of Africa)* Wiley-Blackwell; 1997

cxlvi Abun-Nasr, J. *A History of the Maghrib in the Islamic Period* Cambridge University Press (August 28, 1987)

cxlvii O'Shea, S. *Sea of Faith* Profile Books 2006

cxlviii Westermarck E., *Ritual and Belief in Morocco* Routledge Revivals 2013

cxlix Zahra Rose Water Company, Kerman, Iran Available from www.zahrarosewaterco.com/ 2016 Accessed 10.11.16

cl The World Population 2017 Available from www.geoba.se/population.php?pc=world 2016 Accessed 11.10.16

cli Hass, N. "*Francis Kurkdjian and Fabien Ducher, Changing History in a Bottle*". The New York Times (Style Magazine) September 24, 2015. ISSN 0362-4331. Retrieved 2015-10-26.

clii Anon. *Penny Cyclopaedia of the Society for the Diffusion of Useful Knowledge.* London, England; 1841:158.

cliii Hüsnü Can Baser, K. Altintas, A. PhD, Kürkçüoglu, M. *Turkish Rose: A Review of the History, Ethnobotany, and Modern Uses of Rose Petals, Rose Oil, Rose Water, and Other Rose Products* American Botanical Council HerbalGram. 2012;

cliv Shahbazi, S. Shahbazi, S. *Byzantine Iranian Relations* in Encyclopedia Iranica 1990. Vol. IV, pp. 588-599.

clv Thompson, R. *A Dictionary of Assyrian Botany*. London, England: The British Academy; 1949.

clvi Schmidt E. *Production of Essential Oils*. In: Baser K, Buchbauer. G, eds. *Handbook of Essential Oils: Science, Technology and Applications*. Boca Raton, FL: CRC Press; 2010

clvii Schmidt E. *Production of Essential Oils. In*: Baser KHC, Buchbauer G, eds. Handbook of Essential Oils: Science, Technology and Applications. Boca Raton, FL: CRC Press; 2010:83119.

clviii Altintas A. *Rose, Rose Water, Historical, Therapeutic and Cultural Perspectives*. Istanbul, Turkey: Maestro Publishing; 2010.

clix Thompson RC. *A Dictionary of Assyrian Botany*. London, England: The British Academy; 1949.

clx Altintas A. *Rose, Rose Water, Historical, Therapeutic and Cultural Perspectives*. Istanbul, Turkey: Maestro Publishing; 2010.

clxi Altintas A. *Rose, Rose Water, Historical, Therapeutic and Cultural Perspectives*. Istanbul, Turkey: Maestro Publishing; 2010.

clxii Flückiger FA, Hanbury D. Pharmacographia: *A History of the Principal Drugs of Vegetable Origin, Met Within Great Britain and British India*, 2nd ed. London, England: Macmillan and Co.; 1879.

clxiii Flückiger FA, Hanbury D. Pharmacographia: *A History of the Principal Drugs of Vegetable Origin, Met Within Great Britain and British India*, 2nd ed. London, England: Macmillan and Co.; 1879.

clxiv Baytop T. *Osmanlı İmparatorluğu Döneminde Anadolu'da Yağ Gülü Yetiştirilmesi ve Gül Yağı.* Tıbbi ve Aromatik Bitkiler Bülteni. 1990; 4:8-10.

clxv Flückiger FA, Hanbury D. Pharmacographia: *A History of the Principal Drugs of Vegetable Origin, Met with in Great Britain and British India*, 2nd ed. London, England: Macmillan and Co.; 1879.

clxvi Flückiger FA, Hanbury D. Pharmacographia: *A History of the Principal Drugs of Vegetable Origin, Met with in Great Britain and British India*, 2nd ed. London, England: Macmillan and Co.; 1879.

clxvii Loeben, C., Kappel. S., *Die Pflanzen im altägyptischen Garten. Ein Bestandskatalog der ägyptischen Sammlung im Museum August Kestner.* (The Plants of Ancient Egyptian Gardens. A Catalogue of the Egyptian Collection of the Museum August Kestner). Leidorf, Rahden 2009, ISBN 978-3-86757-452-5

clxviii Ibid cxl

clxix Altintas A. *Rose, Rose Water, Historical, Therapeutic and Cultural Perspectives. Istanbul, Turkey*: Maestro Publishing; 2010.

clxx Scarman T. *The Healing Propertie of Rosewater and Rose Oil* listed in flower essences, originally published in Positive Health Online issue 73 - February 2002

clxxi Personal communication by email 2012

clxxii Scarman T. *The Healing Properties of Rosewater and Rose Oil* listed in flower essences, originally published in Positive Health Online issue 73 - February 2002

clxxiii Ochir, S., Ishii, K., Park, B. et al. *Botanical origin of Mei-gui Hua (petal of a* Rosa *species)* J Nat Med (2010)

clxxiv Koloski-Ostrow A. *Raising a Really Big Stink* Brandeis Magazine http://www.brandeis.edu/magazine/2013/spring/arts-and-culture/roman%20smells.html

clxxv Rant M. *The Visible Past* Simon & Schuster 1992 p.

clxxvi Rant M. *The Visible Past* Simon & Schuster 1992 p.

clxxvii Greenberg M. *The perception of odor is not a surrogate marker for chemical exposure: a review of factors influencing human odor perception*. Clin Toxicol (Phila). 2013 Feb;51(2):70-6. doi: 10.3109/15563650.2013.767908.

clxxviii Homer in the Illiad (XXIII, 186-7)

clxxix *L 'Ekat0V ÖéÖtVOV* appears in Lazarme, J. *De morbis mulierum*, 2, p. 135. 1729 Wellcome Library

clxxx Le Wall, C. *The Curious Lore of Drugs and Medicines: Four Thousand Years of Pharmacy.* (Garden City, New York: Garden City Publishing Co. Inc.: 1927) and Parker, Linette A. "A Brief History of Materia Medica," in *The American Journal of Nursing*, Vol.15, No. 9 (June 1915). pp 729-734.

clxxxi Le Wall, C. *The Curious Lore of Drugs and Medicines: Four Thousand Years of Pharmacy.* (Garden City, New York: Garden City Publishing Co. Inc.: 1927) and Parker, Linette A. "A Brief History of Materia Medica," in *The American Journal of Nursing*, Vol.15, No. 9 (June 1915). pp 729-734.

clxxxii Brun, J. *The Production of Perfumes in Antiquity: The Cases of Delos and Paestum American Journal of Archaeology* Vol. 104, No. 2 (Apr., 2000), pp. 277-308

clxxxiii Ibid clxvi

clxxxiv Ibid clxvi

clxxxv Le Wall, C. *The Curious Lore of Drugs and Medicines: Four Thousand Years of Pharmacy.* (Garden City, New York: Garden City Publishing Co. Inc.: 1927) and in Parker, Linette A. *A Brief History of Materia Medica,* in *The American Journal of Nursing*, Vol.15, No. 9 (June 1915). pp 729-734.

clxxxvi Dioscorides. *De Materia Medica* I, 30 Loeb Classical Library Trans. Osbaldeston 2000

clxxxvii Pliny the Elder. *Naturalis Historia* (XXI, 112-120), Trans. Rackham, H. Harvard University Press (January 1, 1952

clxxxviii Pliny the Elder. *Naturalis Historia* (XXI, 112-120), Trans. Rackham, H. Harvard University Press (January 1, 1952

clxxxix Pliny the Elder. *Naturalis Historia* (XXI, 112-120), Trans. Rackham, H. Harvard University Press (January 1, 1952

cxc Dioscorides *Materia Medica* I, 30 Loeb Classical Library Trans. Osbaldeston 2000

cxci Dioscorides *Materia Medica* I, 30 Loeb Classical Library Trans. Osbaldeston 2000

cxcii The issue to which reference is made to Olivieri, A. *Aetii Amideni medicinales books [Corpus Medicorum Graecorum*, vol. 8.1] Leipzig 1935. The work of Aetius, in several manuscripts, is divided in four sections (tetpåßLß) cot).

cxciii Mello M. *Rosae* Naples 2003 p. 48

Theophrastus (I, 113) that contains the recipe i] following: ööötvov, T6Ötvov oi3T (Dg •ö6ö (DV Kai éllfU7k1éV (DV figépuv Kai Vt3Ktc_t 7, é) cuiou itUÄtKÖg gig, é. g13åÄÄovtu öéöu nept-G (pi77Etv tot) ßiKOU b00vicp, äZ0) 0EV öé. ppcatt CS1 & tot '); 7171'0Åévoug öklßpoug uicpviötov Kai h) .10Üv h! Lépug K Rui oi3tcog GEtpåjouvtu too; [3iKou; hi ouviÖov ev oi'K0tg tiKpÜTOtg.ttvég OE ét € på TtVU tot; ööööt; Piotn & OE éGttv ÖlüTöv öéöov klövov Kai enuiou 0K € UC10iu. TIVég OE fiÄtoÜc; tV ', DLAA'tbv 13iKOV eig cppéup € 3Öutog vyuzpoü mtépug Pl.

cxciv Amigues,S., Théophraste. Recherches sur les plantes. À l'origine de la botanique. Paris, Belin, 2010. 1 vol. 18,5 x 28,5 cm, XI-414 p., 900 ill.

cxcv Conan, M. *Botanical Progress, Horticultural Innovation and Cultural Changes*, Volume 28 Dumbarton Oakes Harvard 2007

cxcvi Subtelny, M. *Visionary Rose: Metaphorical Interpretation of Horticultural Practice in Medieval Persian Mysticism Published in "Botanical Progress, Horticultural Innovation and Cultural Change"*, XXVIII Dumbarton Oaks Colloquium on the History of Landscape Architecture, Dumbarton Oaks, May 6-8, 2004, Eds. Conan & Kress. Dumbarton Oaks 2009. Article (misc.) 2007 p.15.

cxcvii Altintas A. Rose, *Rose Water, Historical, Therapeutic and Cultural Perspectives*. Istanbul, Turkey: Maestro Publishing; 2010.

cxcviii Yusuf Has Hajib. *Kutadgu Bilig*. trans. Arat RR, Ankara: Türk Tarih Kurumu Yayinevi; 1988. Society Publications. 1988

cxcix Al-Dimashqi. *Nühbetu'd-Dehr fî Acâibi'l-Berr ve'l-Bahr* -Türkiye Kaynakçası

cc Rebve. S, Şemsuddin, Ebu S. Muhammed, A. b. *Ebi Talib el-Ansari ed-Dimashqi, Nuhbetu'd-Dehr fi Acaibi'l Berr ve'l Bahr,* Beyrut, 1988. In: *Abdülhalik Bakir, Ortaçağ İslam Dünyasında Itriyat, Gıda, İlaç Üretimi ve Tağşişi,* trans*. Production and Adulteration of Cosmetics, Food and Medicines in Medieval Islamic World*. Ankara; 2000.

cci Rebve. S, Şemsuddin, Ebu S. Muhammed, A. b. *Ebi Talib el-Ansari ed-Dimashqi, Nuhbetu'd-Dehr fi Acaibi'l Berr ve'l Bahr, Beyrut, 1988*. In: *Abdülhalik Bakir, Ortaçağ İslam Dünyasında Itriyat, Gıda, İlaç Üretimi ve Tağşişi,* trans*. Production and Adulteration of Cosmetics, Food and Medicines in Medieval Islamic World*. Ankara; 2000.

ccii Mercil E. *Türkiye Selçuklularında Meslekler Careers in Anatolian Seljuks*. Ankara: Türk Tarih Kurumu Yayinevi; 2000.

cciii Rumi M., Divan-i Kebir, Ergin N. trans. *Ankara and Walla Walla: Republic of Turkey* Ministry of Culture and Current; 1995.

cciv Ibnul-Baytar, el-Mufredat, Sontheimer, J.; *Große Zusammenstellung über die Kräfte der bekannten einfachen Heil-und Nahrungsmittel von Abu Mohammed Abdallah Ben Ahmed aus Malaga bekannt unter den Namen Ebn Baithar, II*. Band Stuttgart; 1842: p.482

ccv Özgüdenli O. *Bir İlhan'lı şehir modeli (Rab-i Raşidi),* Esnaf ve Ekonomi Seminer, Istanbul. Vol 1. 2003:112.

ccvi Gökce N. Edirne Sultan II. *Bayezid Darüşşifasi Vakfiyesine göre Darüşşifada Çalışan Personel ve Kullanılan İlaçlar* (*Personnel and Medicines in the Hospital according to the Charter of the Sultan Bayezid the Second Foundation Hospital in Edirne, Turkey*). The Proceedings of the IV. History of Turkish Pharmacy Meeting, Istanbul. 2000: 317-318.

ccvii Gökce N. Edirne Sultan II. *Bayezid Darüşşifasi Vakfiyesine göre Darüşşifada Çalışan Personel ve Kullanılan İlaçlar* (*Personnel and Medicines in the Hospital according to the Charter of the Sultan Bayezid the Second Foundation Hospital in Edirne, Turkey*). The Proceedings of the IV. History of Turkish Pharmacy Meeting, Istanbul. 2000: 317-318.

ccviii Haghighi, M. Tehranifar, A. Nikbakht, A. Kafi, M. *Research and current profile of Iranian production of Damask Rose (Rosa x damascena ill.)* 10.17660/ActaHortic.2008.769.64

ccix Kiani M., Zamani Z, Khalighi, A. Byrne, D. *Microsatellite analysis of Iranian Damask rose (Rosa damascena Mill.) germplasm* Plant Breeding 129(5) · 2009 DOI: 10.1111/j.1439-0523.2009. 01708.x

ccx Ibid cxcii

ccxi Iran Rose Oil, source: pRESS TV http://www.iran-daily.com/News/154714.html 03.11.16

ccxii Houtum-Schindler, Albert *Eastern Persian Irak,* London: Royal Geographical Society, J. Murray 1897, *p. 114*.

ccxiii Baytop T. *Osmanlı İmparatorluğu Döneminde Anadolu'da Yağ Gülü Yetiştirilmesi ve Gül Yağı.* Tıbbi ve Aromatik Bitkiler Bülteni.1990; 4:8-10.

ccxiv Levey M. *The Medical Formulary of Aqrabadhin of Al Kindi* (Translated with a study of its Materia Medica). Madison, WI: University of Wisconsin Press; 1966.

ccxv Altintas A. *Rose, Rose Water, Historical, Therapeutic and Cultural Perspectives*. Istanbul, Turkey: Maestro Publishing; 2010

ccxvi Levey M. *The Medical Formulary of Aqrabadhin of Al Kindi* (Translated with a study of its Materia Medica). Madison, WI: University of Wisconsin Press; 1966.

ccxvii Ibn Sina*. El-Kanun Fi't-Tıbb*. Vol 2, 1st ed. Kahya E, trans. Ankara: Atatürk Kültür Merkezi Baskanligi Yayinlari; 2003.

ccxviii Ibnul-Baytar, el-Mufredat, Sontheimer, J.; Sontheimer*; Große Zusammenstellung über die Kräfte der bekannten einfachen Heil-und Nahrungsmittel von Abu Mohammed Abdallah Ben Ahmed aus Malaga bekannt unter den Namen Ebn Baithar, II.* Band Stuttgart; 1842:482

ccxix Sirvanli M. *Kemaliye (1430),* Yelten M, ed. Istanbul: Istanbul University Faculty of Education Publications; 1993.

ccxx Geredeli Ishak b. Murat, *Edviye-i Müfrede (1387*). Canpolat M, Önler Z, eds. Ankara: TDK Yayinlari; 2007.

ccxxi Gayet-ül Beyan Fi *Tedbir-i Beden-il* Insan, Vol 1. Özkök A, trans. Ankara: Ve-Ga Publications; 1991.

ccxxii Boskabady, M., Shafei, M., Saberi, Z., Amini, S. *Pharmacological Effects of Rosa* Damascena Iranian Journal of Basic Medical Sciences Vol. 14, No. 4, July-Aug 2011, 295-307

ccxxiii Boskabady, M., Shafei, M., Saberi, Z., Amini, S. *Pharmacological Effects of* Rosa Damascena Iran J Basic Med Sci. 2011 Jul-Aug; 14(4): 295–307.

ccxxiv Husnu Can Base, Buchbauer G., *Handbook of Essential Oils: Science, Technology, and Applications* CRC Press, 2009

ccxxv Sarı N, Tuğ R. *Enderun-ı Hümâyun Kilâr-ı Hassa Başkullukçusu Derviş Mehmed'in Dühn Terkiplerine Ait Risalesi* Proceedings of the IV. History of Turkish Pharmacy Meeting. Istanbul. 2000:283-295.

ccxxvi Baser K. *Turkish Rose Oil*. Perf. Flavour. 1992;17(3):45-52

ccxxvii Verma RS[1], Padalia RC, Chauhan A, Singh A, Yadav AK. *Volatile constituents of essential oil and rose water of damask rose (Rosa damascena* Mill.) *cultivars from North Indian hills.* Nat Prod Res. 2011 Oct;25 (17):1577-84. doi: 10.1080/14786419.2010.520162. Epub 2011 Jun 28.

ccxxviii Lawless, J. *The Illustrated Encyclopedia of Essential Oils.* Element Books 1995 ISBN 1-85230-661-0.

ccxxix Leffingwell J. *Rose (Rosa damascena)* http://www.leffingwell.com/rose.htm 10.1116

ccxxx Younis, A. *Percentage Composition of the Components Identified through Gas Chromatography in Essential Oil of Rosa Extracted through Hexane Solvent* Extraction Floriculture and Ornamental Biotechnology 2007

ccxxxi Mahboubi' M. J *Rosa damascena as holy ancient herb with novel applications* Tradit Complement Med. 2016 Jan; 6(1): 10–16. Published online 2015 Oct 30.doi: 10.1016/j.jtcme.2015.09.005

ccxxxii Farrar, L. *Gardens and Gardeners of the Ancient World: History, Myth and Archaeology* Casemate Publishers, 29 Feb 2016

ccxxxiii Vecera L. *Classic Roses: A Concise Guide in Colour*. Secaucus, NJ: Chartwell Books Inc.; 1989.

ccxxxiv Vecera L. *Classic Roses: A Concise Guide in Colour*. Secaucus, NJ: Chartwell Books Inc.; 1989.

ccxxxv Altintas A. *Rose, Rose Water, Historical, Therapeutic and Cultural Perspectives*. Istanbul, Turkey: Maestro Publishing; 2010.

ccxxxvi SubRosa. Scotland Europa website. Available at: http://www. sdi.co.uk/scotland-europa/about-scotland-europa/subrosa.aspx. Accessed October 9, 2012.

ccxxxvii Altintas A. *Rose, Rose Water, Historical, Therapeutic and Cultural Perspectives*. Istanbul, Turkey: Maestro Publishing; 2010.

ccxxxviii Altintas A. *Rose, Rose Water, Historical, Therapeutic and Cultural Perspectives*. Istanbul, Turkey: Maestro Publishing; 2010.

ccxxxix Altintas A. *Rose, Rose Water, Historical, Therapeutic and Cultural Perspectives*. Istanbul, Turkey: Maestro Publishing; 2010.

ccxl Columella L. *Scriptores rei rusticae* (I, Intr., 27), trans. Bracciolini 1414 Loeb Classical Library DOI: 10.4159/DLCL.columella-agriculture.1941

ccxli Kock, K. *Die Bäume und Sträucher des alten Griechenlands*. The ed., Berlin 1884; provided by G. Lafaye, in "Dict. Ant. grecq. rom.", Ill (1900), s. v. hortus, p. 276 ff. (CH. Joret, *La rose dans l 'Antiquité et au Moyen Age: histoire, légende et symbolisme*, Paris 1892

ccxlii *Theophrastus, Enquiry into Plants* or *Historia Plantarum (Greek: Περὶ φυτῶν ἱστορία,* Peri phyton historia*) c. 350 BC – c. 287 BC. Trans.* Hort A. *Loeb Classical Library 1916*

ccxliii Plinius Secundus, G. *Naturalis Historia* XXI, Preface and books 1-2 Harvard Univ. Press Cambridge, Mass. 1991

ccxliv Pliny *Naturalis Historia* Pliny, xxi. 9. Harvard Univ. Press Cambridge, Mass. 1991

ccxlv Plinius Secundus, G. *Naturalis Historia* XXI, 12; XX, 86; XXI, 116; XXIV, 167. Harvard Univ. Press Cambridge, Mass. 1991

ccxlvi Caneva. G, Bohuny, L., *Botanic analysis of Livia's villa painted flora (Prima Porta, Roma)* Pages 149-155 Journal of Cultural Heritage Volume 4, Issue 2, April 2003, Pages 149–155

ccxlvii S. Coggiatti, *Rose di ieri e di oggi,* Mondadori, Milano, 1986.

ccxlviii S. Coggiatti, *Rose di ieri e di oggi*, Mondadori, Milano, 1986.

ccxlix M. Gabriel, *Livia's Garden Room at Prima Porta* I.A.G. Qb 185a New York. 1955.

ccl Ibid vi. p.59

ccli Cancik, H.; Schneider, H. (eds.). *"Poseidonia, Paistos, Paestum."*. Brill's New Pauly. Brill Online. Retrieved November2013.

cclii J. Geophys. Eng. 8 (2011) S23–S32 doi:10.1088/1742-2132/8/3/S03 Geophysical prospecting in archaeology: investigations in Santa Venera, south suburb of Poseidonia-Paestum, Campania, southern Italy A Loperte1,4, A Satriani1, M Bavusi1, V Lapenna1, S Del Lungo2, R Sabelli3 and F T Gizzi2

ccliii Mello M., *The supposed decline of Paestum in etc) tardorepubbli-cana and imperial: two new documents*, '' Annals Fac. Lett. Univ

ccliv Columella *De re Rustica* X, 35 ff. Loeb Classical Library edition: Vol. I (Books 1-4) by H. B. Ash, first published in 1941; Vols. 2 and 3 (Books 5-12 and the *de Arboribus*) by E. S. Forster and E. Heffner, first published in 1954-1955.

cclv Martial Epigrams VI, 80 Martial. *Epigrams, Volume I: Spectacles, Books 1-5.* Edited and translated by D. R. Shackleton Bailey. Loeb Classical Library 94. Cambridge, MA: Harvard University Press, 1993.

cclvi Aratus, *Phaenomena* IXII p.122 Loeb 34

cclvii Plinius Secundus, G. *Naturalis Historia* XXI, Preface and books 1-2 Harvard Univ. Press Cambridge, Mass. 1991

cclviii Plinius Secundus, G. *Naturalis Historia* XXI, Preface and books 1-2 Harvard Univ. Press Cambridge, Mass. 1991

cclix Plinius Secundus, G. *Naturalis Historia* XXI, Preface and books 1-2 Harvard Univ. Press Cambridge, Mass. 1991

cclx Mello M. *Rosae* Step Plinian (xiii, 24) Mello's note says *contains inaccuracies, since re-called Antiochus and places censorship of the two characters one hundred years* p.63

cclxi Ellis, R. (2012*) 'Note on Propertius IV. 5. 61, 2'*, in Wright, W., Bywater, I., and Jackson, H. (eds.) *The Journal of Philology:* Cambridge: Cambridge University Press, pp. 267–267.

cclxii Virgil Georgics, Aeneid. IV, 119. Loeb Classical Library No. 63. Trans. Fairclough, H. Rev. Goold C. Cambridge, MA: Harvard University Press, 1993.

cclxiii Vergil. *Bucolics, Aeneid, and Georgics of Vergil*. J. B. Greenough. Boston. Ginn & Co. 1900.

cclxiv Kock, K. *Die Bäume und Sträucher des alten Griechenlands*. The ed., Berlin 1884; provided by G. Lafaye, in "Dict. Ant. grecq. rom.", Ill (1900), s. v. hortus, p. 276 ff. (CH. Joret, *La rose dans l 'Antiquité et au Moyen Age: histoire, légende et symbolisme*, Paris 1892 p.158

cclxv BRUN, J. *Une parfumerie ronzazne sur le forum de Paestu*m, in 'MENA', CX (1998), p. 419 ff.; ID., *The boutique* nr. 10, E. Greek, E. & AliiI, Poseidon-Paestunz IV, Rome 1999, p. 19 ff.

cclxvi Cf. J. BRUN, *The boutique*. It., p. 24.

cclxvii Martial Epigrams VI, 80 Martial. *Epigrams, Volume I: Spectacles, Books 1-5.* Edited and translated by D. R. Shackleton Bailey. Loeb Classical Library 94. Cambridge, MA: Harvard University Press, 1993.

cclxviii Vergil. *Bucolics, Aeneid, and Georgics of Vergil*. J. B. Greenough. Boston. Ginn & Co. 1900.

cclxix Martial Epigrams VI, 80. *Epigrams, Volume I: Spectacles, Books 1-5.* Edited and translated by D. R. Shackleton Bailey. Loeb Classical Library 94. Cambridge, MA: Harvard University Press, 1993.

cclxx Pliny. Flor., I, The: *Omium no way Italiae sed toto orbe terrarum* but- chewima *Campaniae plaga est. Nihil mollius caelo: denique bis Floribus Verna*t Plinius Secundus, G. *Naturalis Historia* XXI, Preface and books 1-2 Harvard Univ. Press Cambridge, Mass. 1991

cclxxi Mello, M. *Rosae Il fiore di Venere* Arte Tiographica Naples 2003 p.59Roman Paestum, cit., P. 152

cclxxii Brun. J. *Une parfumerie romaine*. cit., p. 419 ff.; ID., The boutique nr. 10, cit., P. 19 ff.; ID., The Production of Perfumes cit., p. 290 ff. Mélanges de l'école française de Rome 1998 http://www.persee.fr/doc/mefr_0223-5102_1998_num_110_1_2032

cclxxiii Forbes R. *Cosmetics and perfumery in Antiquity* Studies in ancient technology volume iii Chapter 1. Pp. 26, 27 Leiden

cclxxiv Brun J*. The production of perfumes in antiquity: the cases of Delos and Paestum.* American Journal of Archaeology 2000 104, 277–308.

cclxxv Mattingley *Oxford Journal of Archaeology* Volume 9, Issue 1, Version of Record online: 31 MAY 200

cclxxvi Jashemski, *Archaeological Evidence for Plants in Ancient Vesuvian Gardens* 1991, p. 313-392www.univeur.org 1991, p. 313-392

cclxxvii Ibid cclxi

cclxxviii Theophrastus, *Enquiry into* Coates *The coming of Christianity dethroned by the rose* 1970 *Plants* or *Historia Plantarum* (Greek: Περὶ φυτῶν ἱστορία, *Peri phyton historia*) c. 350 BC – c. 287 BC

cclxxix Day J., *Botany meets archaeology: people and plants in the past* J.Exp.Bot. (2013) doi: 10.1093/jxb/ert068

cclxxx Pliny. Flor., I, The: *Omium no way Italiae sed toto orbe terrarum* but- chewima *Campaniae plaga est. Nihil mollius caelo: denique bis Floribus Verna*t Plinius Secundus, G. *Naturalis Historia* XXI, Preface and books 1-2 Harvard Univ. Press Cambridge, Mass. 1991

cclxxxi Mello M. *Rosae* Step Plinian (xiii, 24) Mello's note says *contains inaccuracies, since re-called Antiochus and places censorship of the two characters one hundred years* p.63

cclxxxii Ibid cclii

cclxxxiii Ibid vi p.73

cclxxxiv Columella L. *Carm., I, 9, 146 ff Scriptores rei rusticae* (I, Intr., 27), trans. Bracciolini 1414 Loeb Classical Library DOI: 10.4159/DLCL.columella-agriculture.1941

cclxxxv Ibid vi

cclxxxvi Potter, J. *The Rose* Callisto 2010 p. 68

cclxxxvii Joret, C. *La Rose dans l'antiquite et au moyen age*. Emile Bouillon, Paris 1892.

cclxxxviii p.163

cclxxxix Coates *The coming of Christianity dethroned by the rose* 1970 p.163

ccxc McCurdy E. *Roses of Paestum*, p.158 London 1900.

ccxci McCurdy E. *Roses of Paestum*, p.158 London 1900.

ccxcii Hurst, C. *Notes on the origin and evolution of our garden roses*, J. Roy. Hort. soc., 66 (1941), pp. 73-82; 242-2? 0, 282-289;

ccxciii Iwata; H. Gaston, A., Denoyés, B. Araki, T., Remay, A., Thouroude, T., Jeauffre; J, Oyant, S., Foucher, F., *The TFL1 homologue KSN is a regulator of continuous flowering in rose and strawberry* The Plant Journal, 2011. DOI: 10.1111 / j.1365-313X.2011.04776.x 2011

ccxciv Fikri Kulakoğlu & Güzel Öztürk New *evidence for international trade in Bronze Age central Anatolia: recently discovered bullae at Kültepe-Kanesh* Antiquity Journal, vol. 89, issue 343, February 2015.

ccxcv Herodotus. *Histories, 8.98.* Loeb Classical Library) Trans. Godley A., 1989

ccxcvi Herodotus. *Histories, 8.98.* Loeb Classical Library) Trans. Godley A., 1989

ccxcvii Plinius Secundus, G. *Naturalis Historia* XXI, Preface and books 1-2 Harvard Univ. Press Cambridge, Mass. 1991

ccxcviii *"O, you who believe! When you intend to offer the prayer, wash your faces and your hands (forearms) up to the elbows, wipe your heads, and (wash) your feet up to the ankles. If you are in a state of Janaba purify yourself."* Quran 5:6

ccxcix Hansen. V. *The Silk Road, A New History*. Oxford University Press 2012

ccc Schafer, E. The Golden Peaches, A Study of T'ang Exotics September 1985

ccci Hansen. V. *The Silk Road, A New History*. Oxford University Press 2012

cccii Chuang R. *Tibetan Buddhism, Symbolism, and Communication Implications in the (Post)modern World* Intercultural Communication Studies XV: 1, California State University, San Bernardino 2006

ccciii Hindu of Universe http://www.hinduofuniverse.com/hou/holy-powders-pastes.html 21.12.2016

ccciv Eduljee, K. *Zoroastrian Heritage Available from* www.heritageinstitute.com/ Accessed 19.12.16

cccv Al-Zahrani K., *The door of the Kaaba remains one of history's mysteries* Al Arabiya Mecca 2016

cccvi Janazah, *Death and Burial of a Muslim, Teaching s of Islam (Talim-ul-Haq)* Part 10.

cccvii Alkiviadis C. *Great Week and Pascha in the Greek Orthodox Church* (Brookline: Holy Cross Press, 1992), pp. 89-121.

cccviii Bahá'u'lláh. *The Kitáb-i-Aqdas.* Bahá'í World Centre, 1992 edition p. 254 Retrieved 10.10.2016

cccix Foltz, R., *Religion and Overland Trade in Asia, 1000 BC to AD 1400* Microsoft® Encarta® Encyclopaedia 2000. © 1993-1999 Microsoft Corporation.

cccx Lubec, G; Holauerghsrthbek, J; Feldl, C; Lubec, B; Strouhal, E, (4 March 1993). *"Use of silk in ancient Egypt"*. Nature 1993. 362 (6415): 25.

cccxi Foltz, R., *Religion and Overland Trade in Asia, 1000 BC to AD 1400* Microsoft® Encarta® Encyclopaedia 2000. © 1993-1999 Microsoft Corporation.

cccxii Vecera L. *Classic Roses: A Concise Guide in Colour*. Secaucus, NJ: Chartwell Books Inc.; 1989.

cccxiii Vecera L. *Classic Roses: A Concise Guide in Colour*. Secaucus, NJ: Chartwell Books Inc.; 1989.

cccxiv Foltz, R., *Religion and Overland Trade in Asia, 1000 BC to AD 1400* Microsoft® Encarta® Encyclopaedia 2000. © 1993-1999 Microsoft Corporation.

cccxv Haghighi, M., A. Tehranifar, A. Nikbakh and M. Kafi, 2008. *Research and current profile of Iranian production of damask Rose (Rosa damascena Mill.),* Proc. XXvii iHC-s2 Asian Plants with Unique Hort. Potential eds.in-Chief: Donglin Zhang et al. Acta Hort. 769, isHs pp. 449- 455.

cccxvi Haghighi, M., A. Tehranifar, A. Nikbakh and M. Kafi, 2008. *Research and current profile of Iranian production of damask Rose (Rosa damascena Mill.),* Proc. XXvii iHC-s2 Asian Plants with Unique Hort. Potential eds.in-Chief: Donglin Zhang et al. Acta Hort. 769, isHs pp. 449- 455.

cccxvii Fougère-Danezan, M et al., *Phylogeny and biogeography of wild roses with specific attention to polyploids* Article *in* Annals of Botany 115(2) · December 2014 DOI: 10.1093/aob/mcu245 · Source: PubMed

cccxviii Ibid xxvi

cccxix Mirali, N. Aziz, R. Nabulsi, I. .Genetic characterization of *Rosa damascena* species growing in different regions of Syria Int. J. Med. Arom. Plants Vol. 2, No. 1, pp. 41-52, March 2012

cccxx Alsemaan, Albatal, T. Baydar, H and Almaarri, K, Genetic *Diversity and Qualitative Variation of Rosa damascena in Syria.* International Journal of Agricultural Research, *6: 429-436.* 2011.

cccxxi Ibid xxvi

cccxxii Bussagli, Mario *Central Asian Painting* ISBN-13: 978-0847801985 Rizzoli 1979 p.33

cccxxiii Ibid cccxvi p.64

cccxxiv Ibid cccxvi p.106

cccxxv Ibid cccxvi p.107

cccxxvi Härtel H. Yaldiz M. *Along the Ancient Silk Routes Central Asian Art from the West Berlin State Museums MetPublications* MOMA New York 1982 p.137

cccxxvii Ibid cccxx

cccxxviii Ibid cccxx p151

cccxxix Ibid cccxx p.169

cccxxx Ibid cccxx p.179

cccxxxi Ibid cccxx p.192

cccxxxii Ibid cccxx p.141

cccxxxiii Ibid cccxx p.141

cccxxxiv Tucker, J. *The Silk Road, Art & History* Philip Wilson 2003

cccxxxv Ibid cccxxviii p. 145

cccxxxvi Ibid cccxxviii p. 169

cccxxxvii Ibid cccxxviii p. 173

cccxxxviii Ibid cccxxviii p. 177

cccxxxix Von le Coq, Albert *Bilderatlas Zur Kunst und Kultugeswchichte Mittel Asiens* Akademische Druck- und Verlagsanstalt (1977) p.81

cccxl Ranson P. *Erotic Art of the East* Littlehampton Book Services Ltd. (1973) p.136

cccxli Keswick, M. Jencks, C., Hardie, A. *The Chinese Garden: History, Art and Architecture* Harvard Uni Press 2003 pp.34, 11

cccxlii Ibid cccxxxv

cccxliii Ibid cccxxxv

cccxliv Ibid cccxxxv

cccxlv Pavaloi, Kalter Uzbekistan: *Heirs to the Silk Road* Thames & Hudson 1997 pp.25, 271

cccxlvi Capon E. Yang L. *Fragrant Space, Chinese Flower & Bird Paintings of the Ming & Qing Dynasties from Gundong Provincial Museum* N.S. W. Government (2000) pp. 44, 45

cccxlvii Muslihu-d-Din Sadi, Eastwick, E (Trans.) *The Rose garden of Shek Muslihu'd-d adi of Shiraz* Octagon 1997

cccxlviii Nikolaus, J. Freiherr von, J. 1727-1817 *Fragmenta botanica, figuris coloratis illustrata: ab anno 1800 ad annum 1809 per sex fasciculos edita /opera et sumptibus Nicolai Josephi Jacquin*. Viennae, Austriae: Typis Mathiae Andreae Schmidt, 1809.

cccxlix Durkin-Meisterernst, Raschmann, Wilkens, Yaldiz, Zieme *Turfan Revisited, First Century of Research into Art and Culture of the Silk Road Research into the Arts and Cultures of the Silk Road* Monographs on Indian Archeology, Art and Philology Volume 17 Edited by the Director of the Museum of Indian Art at the Staatliche Museen zu Berlin - Prussian Cultural Heritage, Marianne Yaldiz, commissioned by the Foundation Board of the Ernst Waldschmid Foundation 2004

cccl Dzhangaliev, A., Salova. T., Turekhanova, P. "*Horticultural Reviews, Wild Apple and Fruit Trees of Central Asia*", Ed. Jules Jannick 2002

cccli *Mansfeld's Encyclopedia of Agricultural and Horticultural Crops*, Ed P. Hanelt. Berlin: Springer-Verlag Publishers (2001).

ccclii Albrecht 1993, 161 pp.; Friedrich & Schuricht 1989, pp. 322

ccccliii Rafferty J. A *discontinuous genetic variation resulting in the occurrence of several different forms or types of individuals among the members of a single species*. New Thinking about Evolution Britannica 2011

ccccliv Botanicheskii institut (Akademiia nauk SSSR). *Flora of the U.S.S.R.*, Springfield, Va. :Israel Program for Scientific Translations ;1968-Vol. X (1971) Page(s) 345-346

Bibliography

Primary Sources

Floras

Rechinger K. Ed. *Flora Iranica* Vols 1 – 181 Natural History Museum Vienna, Austria 1963-2017

Ghazanfar, A. Ed. *The Flora of Iraq* Royal Botanic Gardens, Kew, UK. 1960-2017

Sennikov, A., Komiljon, S, S. Tojibaev F., Khassanov, O, O. Yu, N. Beschko
The Flora of Uzbekistan Project 2017

Post. G. *Flora of Syria, Palestine and Sinai; from the Taurus to Ras Muhammad, and from the Mediterranean Sea to the Syrian Desert.* Beirut, Syria, Syrian Protestant College 1896

Gazelle. *Flora of Palestine.*The Palestinian Biological Bulletin. ISSN 0178-6288. Number 91, July 2009, Rajab 1430. pp.1-31.

Davis P. *Flora of Turkey* Edinburgh University Press 2016

Kurbanov, D. *Flora of Turkmenistan* Biogeography and Ecology of Turkmenistan Volume 72 of the series Monographiae Biologicae 1994 pp 105-128

Polunin, Stainton. *Flowers of the Himalaya* (Repr. of 1984 ed) Published by OUP India 1997-08-28

Wilson E. H., *A Naturalist in Western China* Methuen 1913

Websites

Zhengyi W., Raven P., & Deyuan H.,
Flora of China Science Press (Beijing) &Missouri Botanical Garden (St. Louis) (China and USA) 1994 online since 2004. Available at http://www.efloras.org/florataxon.aspx? Flora id=2&taxon_id=128746 retrieved 23.07.2015

Flora of Kazakhstan Available at http://enrin.grida.no/biodiv/biodiv/national/kazakh/nav/species/flora.htm Retrieved 17.07.2016

Sennikov A., Uotila, P. *Flora of Kyrgyzstan, Floristic studies in Kyrgyzstan* 21017 Available at https://www.luomus.fi/en/floristic-studies-kyrgyzstan Retrieved 09.09.2016

Stewart *Flora of Pakistan* Available at http://www.tropicos.org/Project/Pakistan 1982 Retrieved 24.01.17

Flora of Tajikistan Research Laboratory for Nature Protection" (RLNP) formed by Decree of the Government of the Republic of Tajikistanhttp://www.biodiv.tj/en/page?cat=80 Retrieved 10.01.2017

Phytotaxa. *Rapid international journal of botanical taxonomy* Available at http://biotaxa.org/Phytotaxa/article/view/phytotaxa.282.2.2 2017 Retrieved 11.01.17

Secondary Sources

Garden Roses and their parentage.

Beales P. *Classic Roses* Collins Harvill 1985

Cairns T. (Ed) *Modern Roses 10* American Rose Society 2000 (ARS

Dickerson Brent C. *Roll-Call: The Old Rose Breeder: A Gazetteer of Breeders, Introducers, and Their Roses Through 1920* Universe 2000

Philips R. & Rix M. *Roses* Pan 1988

Quest Ritson C. & B. *The RHS Encyclopedia of Roses* Dorling Kindersley 2003.

Quest Ritson C. *Climbing Roses of the World*. Timber Press 2003 UK

Thomas, Graham S. *The Old Shrub Roses* Dent 1962

Thomas, Graham S. *Shrub Roses of Today* Dent 1955

Thomas, Graham S. *Climbing Roses Old and New* Dent 1965

Thomas, Graham S. The *Graham Stuart Rose Book* Timber Press 1994

History of Roses

Bunyard E. *Old Garden Roses* Country Life 1936

Dickerson Brent C. *The Old Rose Advisor* Timber Press 1992

Dickerson Brent C. *The Old Rose Adventurer* Timber Press 1999

Keays E. E. *Old Roses* MacMillan 1935

Patterson A. *The History of the Rose* Herrne Stephenson 1983

Paul W. *The Rose Garden* Kent & Co. 1863

Potter. J *The Rose* Atlantic Books 2010

Shepherd R. *History of the Rose* Heyden 1954

Fouge-Danezan M., Joly S., Bruneau A., Gao Xin-Fen., Zhang Li-Bing., *Phylogeny and biogeography of wild roses with specific attention to polyploids* Avaiable at: Annals of Botany 115: 275–291, 2015 doi:10.1093/aob/mcu24 Retrieved 18.08.2014

Mello Mario *Rosae* Arte Tipographica Naples 2003

The Silk Road

Whitefield S., *Life along the Silk Road* Murray 1999

Wood F., *The Silk Road.* The Folio Society 2002

Hansen Valerie, *The Silk Road a New History*. OUP 2012

Arab & Muslim Expansionism

O'Shea S. *Sea of Faith: Islam and Christianity in the Medieval Mediterranean World* Paperback. Profile Books 2006

Classics

Theophrastus *Enquiry into Plants (Historia Plantarum) and On the Causes of Plants.* Trans: Hort, A., Loeb Classical Library 1916

Columella L. *Scriptores rei rusticae* Trans: Ash, H., Loeb Classical Library 361.1941

Dioscorides, *De Materia Medica* Loeb Classical Library. Trans: Osbaldeston, T., 2000

Pliny, *Naturalis Historia.* Trans: Rackham, H., Loeb Classical Library 330

Virgil: v.1: Eclogues; Georgics; Aeneid bks. 1-6 Trans: Fairclough. H., Loeb Classical Library 1999

The Bible St. James version. Cambridge University Press 1973

Technical

Mason J. *Nursery Management* Landlinks Press 2004

Heldt, Hans-Walter *Plant Biochemistry* Elsevier 2005

Wilson K., Walker J. *Principles & Techniques of Biochemistry and Molecular Biology 7th. Edition* Cambridge University Press 2011